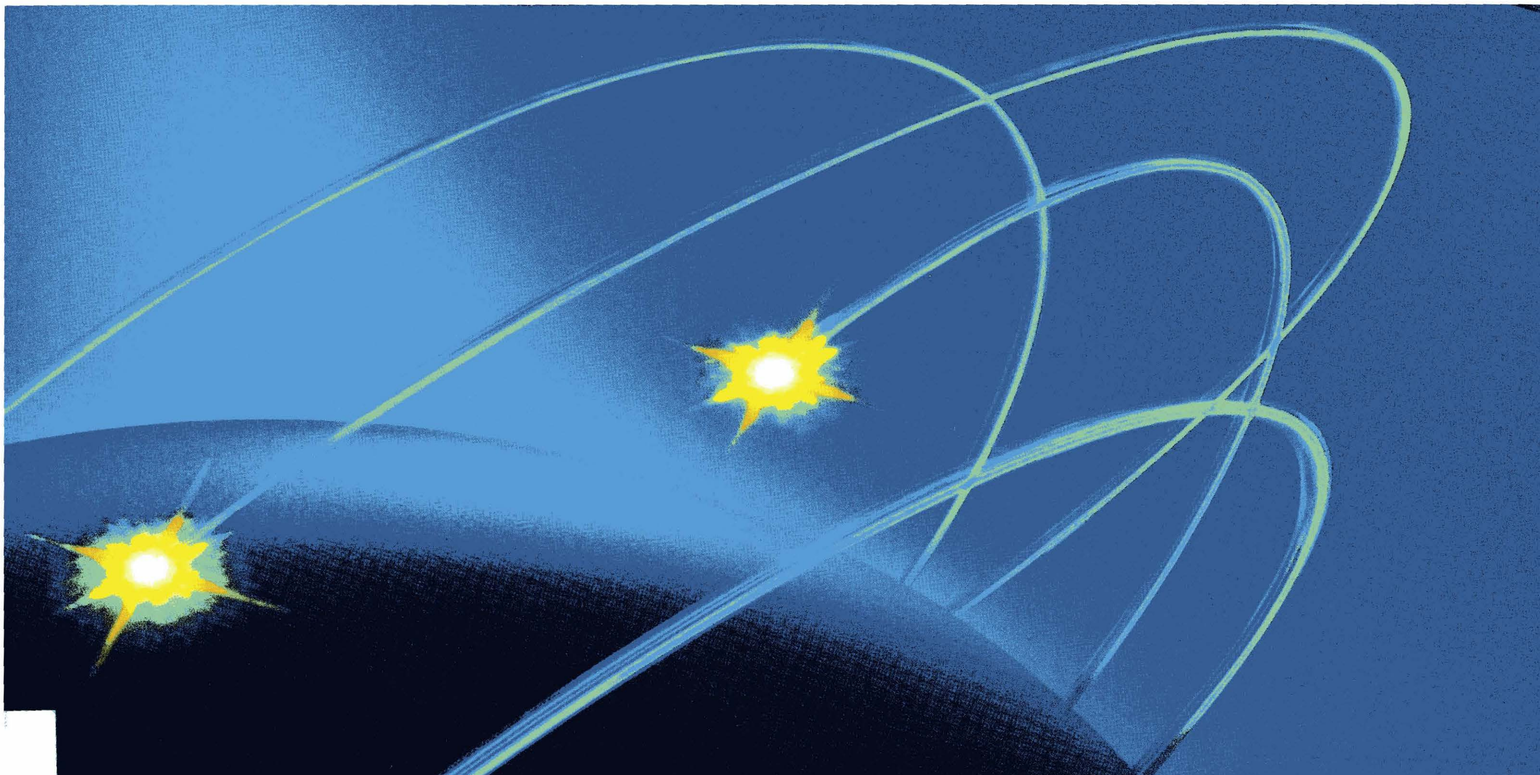


European Information Technology Observatory 99

For a note on the Euro and the ECU exchange rates see inside back cover

European Information Technology Observatory – EITO

EITO Members

EUROBIT · European Association of Manufacturers of Business Machines and Information Technology Industry
Lyoner Strasse 18, D-60528 Frankfurt am Main
Tel. + 49-69-66 03 15 18, Fax + 49-69-66 03 15 10
Internet: http://www.eurobit.org

The European Telecommunications and Professional Electronics Industry, c/o ZVEI/FV K
Stresemannallee 19, D-60596 Frankfurt am Main
Tel. + 49-69-63 02 21 3, Fax + 49-69-63 02 28 8
Internet: FVK.ZVEI@t-online.de

World Business Fair · Office Automation Information Technology · Telecommunications

World of Home and Consumer Electronics

Deutsche Messe AG, Messegelände, D-30521 Hannover
Tel. + 49-511-89 33 100, Fax + 49-511-89 33 102
Internet: http://www.cebit.de
http://www.cebithome.de

FERIA INTERNACIONAL DE INFORMATICA, MULTIMEDIA Y COMUNICACIONES

IFEMA - SIMO TCI
Parque Ferial Juan Carlos I, E-28067 Madrid
Tel. + 34-1-722 50 00, Fax + 34-1-722 58 07
Internet: http://www.simo.ifema.es

Esposizione internazionale dell'information & communications technology

Via Merano 18, I-20127 Milano
Tel. + 39-02-28 3131, Fax + 39-02-28 31 32 13
Internet: http://www.smau.it/magellano

EITO Sponsors

European Telework Development, ETD Central Project Office
Fabrikvej 11, DK-8260 Viby J
Tel. + 45-86-28 64 55, Fax + 45-86-28 64 99
Internet: http://www.eto.org.uk

Computers, Software, Communications
Messe München GmbH, Messegelände, D-81823 München
Tel. + 49-89-949 20 3 50, Fax + 49-89-949 20 3 59
Internet: http://www.systems.de

Company Sponsors

Deutsche Telekom AG
Zentrale Bonn
Reuterstrasse 122, D-53129 Bonn
Tel. + 49-228-18 10, Fax + 49-228-18 18 8 72
Internet: http://www.telekom.de

Telecom Italia
Direzione Generale
Via Flaminia 189, I-00196 Roma
Tel. + 39-06-3 68 81, Fax + 39-06-36 88 29 65
Internet: http://www.telecomitalia.it

With the Support of

European Commission
DG III · Industry
Rue de la Loi 200, B-1049 Brussels
Tel. + 32-2-2 99 11 11, Fax + 32-2-29 50 13 8
Internet: ict-industries@dg3.cec.be

OECD
Directorate for Science, Technology and Industry
2 rue André-Pascal, F-75775 Paris Cedex 16
Tel. + 33-1-45 24-82 00, Fax + 33-1-45 24-85 00
Internet: http://www.oecd.org/dsti

Statistical Definitions
Exchange Rates
Note on the Euro

The general rule in this edition of EITO is to use the ECU as the numeraire currency. Conversion of data from national currencies to ECUs, for both historical series and projections, has been carried out using the average exchange rates for 1997.

At the time of compilation of the statistical data and forecasts given in the EITO 99 yearbook, neither the average exchange rates for 1998, nor the final conversion rates of national currencies against the Euro were yet available.

On 1 January 1999, the Euro was adopted as the common currency of eleven Member States of the EU: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. On 31 December 1998, the conversion rates of the Euro against the eleven national currencies and the ECU (the latter, at the rate of one to one), were irrevocably fixed without changing the external value of the ECU against the US Dollar. It is the opinion of the Task Force that figures for the years 1999 onwards denominated in ECU in this edition of EITO may also be taken as their best estimates of figures denominated in Euro.

ECU Exchange Rates 1995 – 1997, units per ECU

	1995	1996	1997
Austria	13.18	13.43	13.83
Belgium	38.56	39.32	40.54
Denmark	7.32	7.36	7.49
Finland	5.71	5.83	5.88
France	6.52	6.49	6.62
Germany	1.87	1.91	1.97
Greece	302.75	305.48	309.41
Ireland	0.82	0.79	0.75
Italy	2,129.41	1,958.68	1,930.84
Netherlands	2.09	2.14	2.21
Norway	8.29	8.20	8.02
Portugal	195.95	195.75	198.64
Spain	163.01	150.82	165.99
Sweden	9.32	8.51	8.66
Switzerland	1.54	1.57	1.64
UK	0.82	0.81	0.69
US	1.31	1.27	1.13
Japan	123.01	136.71	137.19

Source: OECD

Local commercial rates

Czech Republic (Crowns)	33.4	34.4	40.3
Hungary (Forints)	193.7	185.4	237.1
Poland (Zlotys)	3.5	3.5	4.2
Russia* (Roubles)	6,834.0	6,248.0	n.a.
Slovak Republic (Crowns)	39.0	38.6	42.6
Slovenia (Tolars)	n.a.	n.a.	n.a.
Estonia (Kroons)	n.a.	n.a.	n.a.

Irrevocably fixed conversion rates between the Euro and the currencies of the Member States adopting the Euro, 1 January 1999

1 Euro	
1.0	**ECU**
40.3399	**Belgian francs**
1.95583	**German marks**
166.386	**Spanish pesetas**
6.55957	**French francs**
0.787564	**Irish pounds**
1,936.27	**Italian lire**
40.3399	**Luxembourg francs**
2.20371	**Dutch guilders**
13.7603	**Austrian schillings**
200.482	**Portuguese escudos**
5.94573	**Finnish marks**

Future editions of the EITO will adopt the Euro as the numeraire currency and will follow the practice which will be adopted by the various European institutions, notably Eurostat, in presentation of data in their publications.

*Russia: resarch is carried out using US Dollars rather than Roubles. The Russian currency's steep devaluation makes local currency research impossible (e. g. in December 1995, the Rouble to ECU exchange rate was 7,140 Roubles to ECU).

Preface

The European Information Technology Observatory - EITO is the established yearbook for the information and communications technology (ICT) industry in Europe. Since its launch in 1993, the EITO has set the standard for market analysis and statistics.

The EITO 99 presents the most comprehensive data currently available about the ICT market in Europe. It also provides special ICT studies as on technological trends and standards. In accordance with the enlargement process of the European Union, EITO has broadened the scope of the countries covered by a special study on the ICT market in Central and Eastern Europe. Another study examines for the first time the ICT market in the Mediterranean basin.

The EITO yearbook contains a new specific section, the "Electronic Commerce Observatory", which has been developed in close co-operation with DG III of the European Commission.

The EITO is a broad and unique European initiative. The EITO members consist of the European associations EUROBIT as representative of the information technology industry and ECTEL as representative of the telecommunications industry, and the European ICT trade fairs CeBIT in Hanover, SIMO in Madrid, and SMAU in Milan.

From the very beginning the EITO has been strongly supported by the Directorate General III Industry of the European Commission, and since 1995 by the Directorate for Science, Technology and Industry of the OECD in Paris.

The EITO 99 has been produced with the support of the EITO sponsors, the trade fair SYSTEMS in Munich, the European Telework Development (ETD, supported by the European Commission, DG XIII), and the EITO company sponsors Deutsche Telekom and Telecom Italia.

The objective of the EITO is to provide an extensive overview of the European market for information and communications technology and to render services to this industry, to users and public authorities. The idea of a European Observatory originated from the President of SMAU, Enore Deotto, and it has taken an exceptional effort by the original members EUROBIT, CeBIT, SIMO, and SMAU to produce this new compendium.

The EITO 99 has been produced in close co-operation between the EITO Task Force experts and leading market research companies, to discuss and guarantee the quality of the statistics and data.

The EITO is an indispensable source of information in marketing and technology for European market players, users of information and communications technology hardware, software and services, for trade organisations and trade fair visitors, for market analysts, for politicians, members of the European Commission and national government representatives worldwide, for organisations involved in research and development, standardisation and education relating to ICT, and last but not least, for the media.

Up-to-date and valid information plays an increasingly important role in business and political decision-making. The EITO aims to support the creation of the Global Information Society as well as to make its contribution to the further economic integration and political unification of Europe.

The initiative will be continued with annual editions of the EITO in March and an EITO Update in autumn as a free of charge supplement to the yearbook.

The EITO Members

Imprint

European Information Technology Observatory 1999

Publisher
European Information Technology Observatory (EITO) - European Economic Interest Grouping (EEIG)
Lyoner Str. 18, D-60528 Frankfurt/Main
Telephone: ++49/69/66 03-15 18
Telefax: ++49/69/66 03-15 10
Internet: http://www.eito.com

EITO Members
EUROBIT, Frankfurt/Main
ECTEL, Frankfurt/Main
CeBIT, Hanover
SIMO, Madrid
SMAU, Milan

EITO Sponsors
ETD, Viby
SYSTEMS, Munich

EITO Company Sponsors
Deutsche Telekom, Bonn
Telecom Italia, Rome

With the Support of
European Commission, DG III Industry, Brussels
OECD, Directorate for Science, Technology and Industry, Paris

Chairman
Bruno Lamborghini

Vice-Chairman
Enore Deotto

Managing Director
Bernhard Rohleder

Project Manager
Carola Peter

Chairman EITO Task Force
Egbert Dozekal

EITO Task Force
Johannes Adler
Annette Becker
Michael Beckmann
Gaetano Bianchi
Michel Boitard
Marco Bozzetti
Umberto Bozzo
Giuseppe Dell'Osso
Alberto De Macchi
John Dryden
Martin Ehrentraut
Iordana Eleftheriadou
Graeme Fraser-Watson
John Gallagher
Francisco Ibañez
Horace Mitchell
Catherine Ozannat-Orsini
Antonio Perrucci
Anton Seitz
Paola Terella
Michael Towara
Vlassios Venner
Howard Wilcox

Liability note
The figures contained in this issue have been carefully elaborated and checked. The authors of this publication, however, exclude any liability for the correctness of the figures.

For copies apply to
EITO Members
EITO Sponsors

Order addresses
See inside front or back page

Price per copy
46,- Euro (plus VAT and mailing)

Price per CD-ROM
46,- Euro (plus VAT and mailing)

Price per copy plus CD-ROM
72,- Euro (plus VAT and mailing)

Design
HWL & Partner Design GmbH, Frankfurt/Main

Editorial advice
Alan Brier, Southampton

Production
Eggebrecht-Presse, Mainz

ISSN
European Information Technology Observatory
ISSN 0947-4862

ISBN
European Information Technology Observatory
ISBN 3-8163-0378-1

Contents

Part One

The technological evolution of ICT and standards

Part Two

The E-commerce market in Europe

The ICT market in Central and Eastern Europe

The ICT market in the Mediterranean basin

Part Three

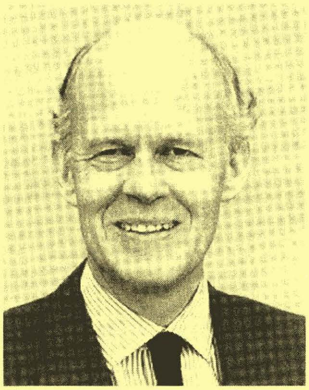
Statistical outlook

Part One

ICT in Europe: the European Commission's view

Each year, in its annual report, the European IT Observatory focuses on a specific theme and examines it in the context of the overall evolution of ICT and the most important associated market drivers. This year, the EITO report includes an examination of the current trends in *electronic commerce,* a powerful driver both for the development of the market for ICT and for the growth of the economy as a whole.

In 1999 for the first time, the report of the *Electronic Commerce Observatory* forms part of the EITO report. The *Electronic Commerce Observatory* was established as a joint initiative of the European Commission and the EITO with the purpose of providing a complete picture of the current penetration of electronic commerce in the marketplace, as well as forecasts regarding the future rate of penetration and an analysis of the motivating factors behind the use of electronic commerce. The work of the *Electronic Commerce Observatory* is based on the findings of a survey carried out using a broad sample of companies, across the European Union and the major industrial sectors. It represents the first study of its kind to address electronic commerce specifically, and to measure its evolution using detailed data collected in the marketplace.



Magnus Lemmel,
Acting Director General Industry,
European Commission

As regards *Central and Eastern Europe* and *the Mediterranean basin,* this year's EITO report includes two important papers, addressing ICT market developments in the countries of these regions, which are of key importance to the European Union in both geographic and economic terms. The extension of EITO's scope to include the countries of Central and Eastern Europe is in accordance with the recommendations of the 1996 Prague and 1997 Brussels EU-CEEC Information Society Fora. In the context of negotiations to enlarge the European Union, up-to-date ICT market information regarding the candidate countries is vital for businesses and policy makers on both sides, in order to improve reciprocal understanding and to prepare for future integration.

Electronic commerce: a shift of focus towards the industrial aspects of electronic commerce

As the survey on the *E-commerce market in Europe* shows, electronic commerce is being rapidly adopted by an increasingly wide spectrum of companies in Europe. Much more than simply another distribution channel, electronic commerce is revolutionising business practices, and transforming traditional industries, while also fostering entirely new businesses and new sectors. In this sense, electronic commerce is accelerating economic growth, and acting as a stimulus for globalisation.

E-commerce has far-reaching economic and social implications in many fields, including the nature of work, the environment and the role of governments. However, the full impact of electronic commerce on firms and industrial sectors has still to be analysed. Basic questions will still remain to be answered, such as how electronic commerce and the network economy will change the organisation of economic activity in Europe and in the USA, and what the main features of the emerging network economy are in relation to specific industrial sectors. In this fast changing environment, governments will have to re-orient their policies so that they ensure that the market functions properly.

In order to overcome the legal barriers to the wide take-up of electronic commerce by businesses, the European Commission has recently adopted a proposal for a Directive that will establish a coherent legal framework for the development of electronic commerce. The proposed Directive will establish specific harmonised rules in place of existing national rules only where it is strictly necessary in order to ensure that businesses and citizens can exchange services throughout the EU without regard to national boundaries. This will include defining an operator's place of establishment, the legal nature of electronic contracts, the liability of intermediaries, dispute settlement procedures, and the role of national authorities. As far as possible, the proposed Directive will seek to ensure that existing EU and national legislation are effectively enforced rather than making new rules.

The focus is now gradually shifting from the legal to the industrial aspects of electronic commerce. As industrial sectors vary substantially in their needs, means and speeds of taking up electronic commerce, it is important to develop a deep understanding of the economic impact of electronic commerce on specific sectors of the economy. Market trends and the dynamics of competition are constantly changing. The ability to understand these changes will give a huge competitive asset to the frontrunners, who will respond to this changing environment by quickly adapting their business strategies.

As indicated in the survey on the *E-commerce market in Europe,* however, the majority of European businesses are adopting a "wait and see" attitude, which seems to be the biggest barrier to the further take-up of electronic commerce. In order to overcome this barrier, it is very important that the experiences of the frontrunners be fully exploited, analysed, consolidated in the form of best practices, and spread widely among the remainder of the business community.

In this sense, raising awareness is a very important, though complex task. As a result of the numerous national and European awareness initiatives, there is already a good level of general awareness of the huge potential of electronic commerce in Europe. The new wave of awareness initiatives should, therefore, shift from the level of general awareness to technical know-how. In other words they should provide practical assistance to European managers on how to do business electronically, as well as how to implement and comply with emerging legal and fiscal requirements.

Continuing growth of the ICT market

Growth of the market for ICT is being fuelled in part by the need to revise business practices in order to take advantage of developments in electronic commerce. But there are other, shorter-term factors also in play: for example, the twin forces of the introduction of the Euro and the looming threat of the "millennium bug" are creating significant demand for ICT products and services. In particular, the Euro (i.e. Economic and Monetary Union) will not only have a profound impact on business strategies, but will also have a number of practical consequences for the day-to-day operations of companies and their accounting and information systems. The changeover to the Euro represents a unique opportunity for reviewing business practices, modernising IT systems and adopting new technologies. It is important that this event is seized upon as an opportunity for improving efficiency and competitiveness, and that companies are ready in time for the new environment, with the right tools and organisational arrangements in place.

In 1998 the overall *market for ICT increased by nearly 9%,* a rate that has continued to grow since 1996. Such a growth rate is difficult to match in any other sector of the economy comparable in scale or importance with ICT. Furthermore, it reflects the willingness of user companies to invest in modernising their organisations and improving efficiency. Nevertheless, this level of growth is the minimum necessary if the EU is to keep pace with other modern economies and begin to address the gap between Europe and the USA.

Promoting the competitiveness of the ICT industry

It is vital that the European ICT industry takes advantage of this healthy growth rate to become more competitive. The European Commission wants to encourage this process, and has taken a number of policy initiatives in this regard. These include measures to liberalise the telecommunications market, to promote electronic commerce and to support research and technological development in this field. In addition to these wide-ranging policy initiatives, the Commission has also launched a *Rolling Action Plan for improving the competitiveness of the ICT industry,* addressing specific problems identified as having an impact on the ICT industry's competitiveness. Actions undertaken in this respect have been described in the 1998 EITO report, but two examples merit further comment:

(i) *Improving the standardisation process* – by implementing an industry-led, market-driven approach. Promoting the convergence of ICT technologies is a priority of the Fifth Framework Programme for R&D. Convergence is now affecting new ICT product design and development. Standards which have, until now, been developed by different standardisation bodies for different products and ICT sub-sectors (telecommunications, consumer electronics, information technologies) must adapt to reflect this trend towards convergence. A key objective is to achieve a sufficient level of interoperability between networks, computers and home equipment.

(ii) *Promoting skills* – encouraging industry-led initiatives aimed at identifying and publicising companies' requirements for individuals with ICT skills. A complementary action is to promote dialogue between industry and educational institutions on how to adapt education and training programmes to industry needs.

The labour market's inability to meet the demand for ICT skills is a growing cause for concern. Recent studies have shown that in 1997 there was the potential for the equivalent of 9.1 million full-time IT-related jobs in the European Union, but the fact that actual employment in this field fell short of this figure is due to the lack of candidates with the appropriate qualifications. While demand for skilled IT professionals is set to increase in the coming years (growing at a projected 8% yearly), the supply of skilled IT professionals is likely to grow at a lower rate, based on current trends in education and training. It is estimated that a gap of 1.6 million equivalent full-time positions will exist by the year 2002.

This situation, paradoxical as it is, given the EU's unemployment problems, represents a major threat not only to the development of the ICT industry, but above all to the competitiveness of the whole European economy. The importance and the scale of the problem demand wide-ranging initiatives, at both EU and Member State level.

The Information Society Technology Programme

Europe's industrial competitiveness, employment, standard of living and continued economic growth depend on its being at the leading edge of the development and take-up of ICT. Community-funded research in ICT is integral to the EU's overall strategy for the Information Society. In response to future needs, the Fifth Framework Programme for R&D includes the *Information Society Technologies Programme,* the objective of which is to realise the benefits of the Information Society, both by accelerating its emergence and by ensuring that the needs of individuals and of business are met.

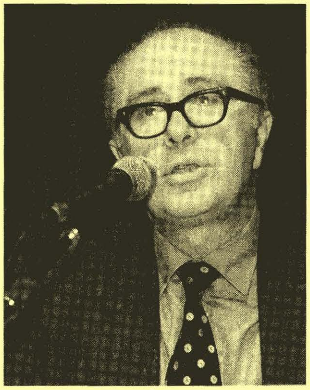
The programme has four inter-related objectives, which will both focus technology developments and enable the close articulation between research and industrial policy needed for a coherent and inclusive Information Society. Firstly, for the European citizens, the objective is to meet the needs and expectations of *private individuals* for high-quality, affordable general-interest services. Secondly, addressing the requirements and concerns of *businesses, workers and consumers,* the objective is to enable both individuals and organisations to innovate and to be more effective in their activities. The third objective is to confirm Europe's leading position in *multimedia content* - central to the Information Society - and to enable Europe to realise the potential of its creativity and culture. Finally, the IST Programme has the objective of driving the development, enhancing the applicability and accelerating the take-up in Europe of the *essential technologies and infrastructures* that form the building blocks of the Information Society.

The ICT industry has an essential role to play for the European economy, by driving the technological developments that are the basis for expanding the applications for ICT in more application areas and securing broader acceptance by users, and also by exploiting the potential offered by the emergence of new forms of business, especially in the field of electronic commerce. By providing the technologies, the infrastructure and the services which will enable a major restructuring and modernisation of business practices to take place, the ICT industry is playing a key role in improving the competitiveness of European business.

The European challenge of the digital economy: the industry's view

A major phase of positive discontinuity for Europe

At the beginning of the new millenium, European markets are facing a major phase of positive discontinuity, under the pressure of converging events: the Euro and consequent increasing economic and market integration, global competition, an open telecommunications environment, a wave of new European entrepreneurialism in ICT, less Euro-pessimism, the emergence of new "brainware generation".



Bruno Lamborghini,
President of EUROBIT
and Chairman of the EITO

The most relevant challenge appears to come from the digital revolution, through the mass diffusion of Internet and electronic commerce and electronic business and through Internet-driven start-ups.

Clear signals of change

There are clear signals of change, even if the speed of change is insufficient:

European IT market growth

The EITO 1999 confirms that the growth rate of the IT markets in Europe has become very close to that in the US limiting and possibly closing the "informatisation gap" between Europe and the US.

Liberalisation of telecommunications

Removal of national monopolies and the opening of traditionally closed markets has progressed rapidly in the telecommunications industry driven by the full competition deadline of 1st January 1998, which represents a fundamental milestone, a model which will be extended to other public services.

In few months during 1998 a number of new entrants have changed the telecommunications market and this process will continue throughout the next few years with enormous benefits for the users and for the progress of the European economy. This will permit alignment of Europe to market conditions of major regional competitors, notably the USA.

The Euro: a catalyst for change

European countries have entered the Euro which will be an extraordinary catalyst for change, because it will mean the end of national sovereignty over money and privileges and will move to real and wider market integration. This means no more protection for national monopolies, no more closed markets, more effective and free circulation of goods, services and business, but hopefully also of jobs throughout Europe.

A new wave of entrepreneurialism

A new wave of European entrepreneurialism in high tech and specifically in the ICT area has developed in 1998 with the emergence of new players, of start-ups is taking advantage of the phase of discontinuity in the ICT sector, of new opportunities in the telecommunications markets and of the development of Internet services and E-commerce.

The old sense of pessimism is gradually being removed. Business Week dedicated a cover story to Europe's start-ups in high tech called "Wake up Europe in high tech".

Deregulation in telecommunications, the Euro and a flood of venture capital will help companies tune up lagging innovation. For the first time the venture capital market, which is a major factor of US growth in high tech, is making advances in Europe: Germany's "Neuer Markt" was up 150% in 1998 and tripled its listings.

A clear example is represented by the success story of the European telecommunications industry through the GSM cellular mobile telephony which has become a world standard.

Europe as a "brainware region"

Many governments are now more clearly perceiving the relevance of policies favouring the diffusion of information technology throughout the economic and social systems, taking into consideration that the future of European competitiveness in the global challenge is closely related to the possibility of becoming a "brainware region" producing high value-added products and services, and no longer a low value manufacturing area.

Unfortunately, a real sense of urgency is still lacking under the pressure of the destabilising factors driven by the growing process of globalisation of finance, markets, technology, industry, jobs and by recessionary trends.

A new generation of "computer-net users"

A new generation of young "computer-net users" is entering the labour market bringing new approaches, new ideas, new cultures throughout all professional activities.

Unfortunately, without a massive diffusion of computer-net literacy in schools, a dramatic gap between ICT haves and have-nots could widen even among young people. Traditional and obsolete systems in education and skill preparation are continuing to oppose change and have a major role in maintaining structural unemployment and impeding taking advantage of new opportunities. Europe has a high rate of youth unemployment which represents a major threat to Europe's future.

The emerging digital economy

A recent report by the US Department of Commerce on "The emerging digital economy" declares that the Internet and E-commerce represent the real engine of the US economy and will drive economic growth for many years to come.

In 1994 3 million people used the Internet. In 1998 more than 100 million people around the world use Internet. It is expected that this number could grow to 1 billion people in 5 years time. Traffic on the Internet has been doubling every 100 days. E-commerce is expected to grow to 300 billion US$ by 2002. Companies throughout the economy are betting on ICT to boost productivity and efficiency.

In the US, in the 60s business spending on IT equipment represented only 3% of capital investment. In 1996 IT's share rose to 45%. In 1997 IT's share represented 56% of all US venture capital investments. More than half of all new US jobs come from ICT-related activities.

In the same report there is a clear warning: to realize the potential the private sector and governments on a global scale must work together to create a predictable, market-driven legal framework to facilitate E-commerce, to create non-bureaucratic means that ensure that the Internet is a safe environment and to create human resource policies that endow students and workers with the skills necessary for jobs in the new digital economy.

Main breakthroughs driving the ICT scenario

Internet and E-commerce represent a major breakthrough driving the development of the digital economy together with other three main breakthroughs which are changing the ICT scenario worldwide, with special impact on Europe.

A main breakthrough is the revolution in telecommunications driven by massive diffusion of computer and optical technology throughout the industry, but strongly enhanced by the new regulatory environment (Telecommunication Bill of 1996 in the US, full liberalisation in the European Union by 1st January 1998 and the WTO Basic Telecommunications Services Agreement in 1997).

The consequences are removal of public monopolies, no more borders between long distance and local services, privatisation and liberalisation processes in many countries at world level.

The outcome is the participation of new players, an increasing competitive environment, new investments in infrastructures, in technologies and new services, tariff reductions which are opening the way to new applications, new business, low communications costs, and mass diffusion of IT equipment and services.

Infinite bandwidth capacity

Telecommunications are rapidly moving from traditional analogue to digital technology with an increasing shift from voice to data and all kinds of digitised information. Diffusion of fibre optics channels and low-cost low-orbit satellite communications are multiplying bandwidth capacity in an exponential way. This trend could lead to a future of infinite bandwidth capacity at minimal cost.

Explosion of digital mobile telephony

A second breakthrough regards the extraordinary diffusion of digital cellular mobile telephony thanks to liberalisation and successful development of new standards (the GSM which represents a major breakthrough and a strong competitive advantage for the European industry). In a few years, the diffusion of mobile telephony has become a major success story and is creating new business and new jobs.

Digital cellular technology will represent a major driver of the digital revolution through the progress in bandwidth capacity (UMTS) which will allow video, multimedia and the Internet on the mobile phone.

Wireless technology is expected to increasingly replace fixed wireline technology in many applications and the extraordinary diffusion of mobile telephony in Europe (70 million subscribers by mid-98 and a yearly growth rate of 66%) represents a fundamental driver for new applications.

Digital cellular mobile technology is a major strength for the European industry and an extraordinary opportunity for regaining European competitiveness and new business in the digital scenario. It will also have a major impact on innovating working conditions.

Convergence as a dynamic process

A third factor is the area of "convergence", which means the digitisation of all communications and information services and contents: the convergence of telecommunications, broadcasting, satellite, Internet, digital media driven by the "digital revolution" and the convergence of players. It is a dynamic process where different industrial cultures are confronted on a global scale. Different rules exist today for the various areas (broadcasting, telecommunications, media). What is not yet clear is the most favourable regulatory environment for the convergence.

Internet, an historical innovation

The major breakthrough is the Internet which seems to represent an innovation of such historical significance as to be compared to the introduction of printing. The Internet has radically changed both the IT area (Intranet replacing traditional IT systems) and telecommunications (diffusion of IP and packet switching). But most relevant is the extraordinary diffusion of the Internet among millions of users throughout the world and the creation of new activities, new firms, and new jobs around Internet.

The Internet success has been driven by a spontaneous and free environment (there was no large business interest behind it during the take-off phase), but now the real growth in the second phase, the phase of E-commerce will be driven by business targets.

E-commerce is turning the extraordinary benefits of the Internet into new business opportunities at different levels: business to business, business to market, government to business and to citizens. E-commerce is a powerful driver in the creation of new business and new jobs. E-commerce represents an opportunity for Europe. We are already seeing a flourishing of new firms, and new business in Europe driven by E-commerce.

As was said in the introduction of the EITO 1998, in parallel with the Euro, the diffusion of E-commerce will accelerate unification of markets. If correctly managed, the combined forces of E-commerce and the Euro will achieve extraordinary progress towards a real Single Market and the Information Society, taking Europe in the next century into the Information Age with a single currency, a single communication technology (Internet-E-commerce), and a single market.

Critical issues at stake

There are still several critical issues to be solved concerning the regulatory environment and standards. They have to be solved at an international level, because E-commerce requires a homogeneous global environment. During 1998 many relevant international events took place on this subject.

It is worthwhile to mention the 9th International Information Industry Congress (IIIC) on "A Global Framework for Electronic Commerce" held in Berlin in September, the OECD Ministerial Conference on E-commerce held in Ottawa in October and the TABD Conference held in Charlotte/North Carolina in November 1998.

All international conferences have improved common views on main regulatory issues related to E-commerce (with special reference to data protection and privacy, security, encryption, harmful content, taxation, electronic contracting) in order to permit the development of a clear and favourable international environment.

The Joint Statement on Electronic Commerce presented by the EU-Japan Industrialist Roundtable in November and the activity of the Global Business Dialogue group points in the same direction.

In all these events the European IT industry association EUROBIT played a major role to promote and accelerate an open development of E-commerce, through a minimum of regulation and a market-driven approach with maximum benefits to users and industry.

Co-operation between the ICT industry organisations

Given that the private sector has a new and major responsibility in the digital scenario, real progress in creating favourable conditions for the development of a successful environment in Europe is closely related to strengthening and focusing the role and convergence of ICT industry associations. Time is of the essence and only a real consensus among the various players in the private sector open to a constructive partnership with the public sector will permit the overcoming of obstacles and speeding up the process.

EUROBIT is making vigorous efforts in this direction seeking co-operation with other ICT associations to reduce fragmented approaches and to reach “one voice”.

Following an MoU signed in November 1997, convergence with the communications technology industry association ECTEL is growing while a favourable understanding is being reached with other industry associations and with the European institutions. In 1998 EUROBIT and ECTEL reached joint industry positions on all major policy issues. The Green Paper on Convergence is only one prominent example.

Moreover a High Level Strategy Group on ICT Standards now brings together five major industry associations in the ICT area, also including consumer electronics, telecommunications services and broadcasting. In the environmental field there has been established a platform of seven associations. Such initiatives are crucial for the optimisation of the policy making procedures in the Internet and E-commerce area.

Skills, "brains", education

High quality skills (brainware) are the basic resources of the new scenario. Investments in education and training with a massive use of ICT, multimedia and Internet represent the strategic areas of investment for industry and government.

Skill shortage is the major barrier for participating in a competitive way in the new scenario. Europe is suffering dramatically from a skill shortage (according to a recent survey, more than 500,000 potential ICT jobs have no response and this number could grow to 1.5 million in few years). Risks of the millenium bug (Y2K) are higher in Europe because of the skill shortage.

Year by year the ICT industry world-wide creates about 600,000 additional jobs. More than 100,000 further jobs could be created if the industry could find sufficiently skilled people.

The skills shortage is a global phenomenon, also threatening the US and Japan in particular. It has become a major factor for investment decisions in all ICT-related businesses. European policy makers have a unique chance and at the same time a unique responsibility in order to meet the ICT skills needs of the economy.

There is a dramatic lack of awareness on this subject and pressures have to come both from the private sector and the public sector to join forces and focus on large investments in digital education, training and lifelong retraining.

A new paradigm shift for Europe

The new economic paradigm shift driven by discontinuity in ICT, if managed in a timely way, will allow changes to be faced and benefits maximised for the European industry and markets. The digital revolution, the widespread diffusion of personal computers and new network appliances, of Internet applications and the development of E-commerce can remove the competitive deficits of Europe in IT, and help in reducing market fragmentation and removing obstacles to change.

Today in Europe there are great new opportunities for strengthening both the ICT industry and market: the discontinuity in IT and telecommunications and the explosion of the Internet and E-commerce applications open new areas and we expect that new opportunities will be fully exploited.

The ICT market in Europe

The data and forecasts presented in this paper have been jointly prepared by IDC and the EITO Task Force on the basis of the latest information available at end of November 1998.

1. Overview

The European ICT market will maintain its current growth pace over the next two years, despite concern over the extent to which economic problems in other regions may affect the European economy.

The following trends continue to drive ICT market developments. These developments take place against a background of moderate but sustained economic growth. Inflation remains low and unemployment continues to fall, albeit slowly. Economic difficulties in certain other regions of the world may however have little impact on the growth of the ICT market in Europe.

General business environment drivers

- increasing cross-border competition across the Euro-zone;
- cost transparency enabled by the Euro currency, driving the need for continuous IT-led productivity improvements;
- mergers and acquisition activity in several industries (finance, retail, business services) driving demand for support in information systems consolidation;
- preparation for the Euro driving all businesses to re-examine their business processes;
- increased acceptance of ICT by individuals (including consumers), encouraging investment by enterprises and administrations in telephone, on-line and E-commerce applications;
- implementation of deregulation in the telecommunication market.

For 1999 and beyond, European companies will be managing multiple and sometimes conflicting ICT priorities, ranging from completion of Year 2000 and Euro management projects, to the deployment of Internet technology for business processes.

ICT deployment drivers

- the increasing *impact of Internet technology* for internal knowledge management applications and for business-to-business E-commerce;
- the incorporation of *Web-enabling capabilities into applications and databases,* enabling easier and effective upgrade of legacy systems into networked intranet/extranet application environments;
- the incorporation of *Web-enabling capabilities into end-user devices and transmission technology* enabling easier access to the Web from any type of end-user device (from personal computers to mobile phones);
- the adoption of *Internet Protocol (IP),* gradually becoming the preferred platform for fixed and mobile services integration and enabling more cost-effective voice and data integration;
- *reduced costs of data communications,* as a result of increasing availability of broadband technology and new generation packet switch technology.

Table 1
Western European Information and Communications Technology (ICT) market, 1998, billion ECU***

	1998 Value	% of IT/TLC	% of ICT
Total IT	**193**	**100.0**	**49.2**
Computer hardware and datacom	77	40.0	19.7
Office equipment	10	4.9	2.4
Software	38	19.8	9.8
Services	53	27.3	13.4
Support services	15	7.9	3.9
Total telecommunications	**199**	**100.0**	**50.8**
Telecommunication equipment	33	16.8	8.5
Telecommunication services	166	83.2	42.2
Total ICT	**392**	**100.0**	**100.0**

Note: * Western Europe includes the 15 EU and 2 non-EU countries (Switzerland and Norway).
** It should be noted that all figures have been rounded to the nearest billion ECU at 1997 constant exchange rates. Total and percentages may not add up due to rounding.

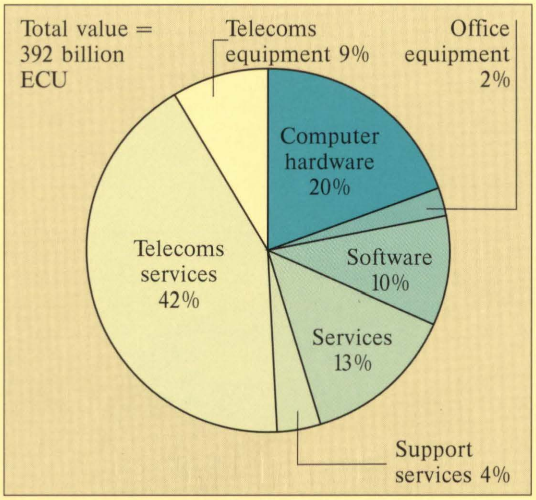


Figure 1
Western European Information and Communications Technology (ICT) market by product, 1998

ICT-contingent drivers

- double-accounting systems for the Single Currency (Euro);
- Year 2000 date change.

ICT market perspectives

In the period 1998-2000 overall ICT spending in Western Europe is expected to grow at an annual rate of around 7.9%. In telecommunications, falling tariffs and early saturation in the penetration of mobile technology (especially in the Nordic countries) will be offset by increasing usage (in terms of duration of communications or quantity of transported information) of the fixed and mobile networks and the enhancement of installed public and private telecommunications to take advantage of new GSM, IP and packet-switched technologies.

IT market growth is expected to confirm the same growth dynamics as in 1998. Demand for software and IT services will drive growth, addressing increasing demand for new IT skills and application features. The shift of IT budget from internal to external expenditure is set to continue, as business users experience limited internal IT capacity to handle both IT systems strategy renovation and contingent requirements. In particular Euro projects will impact increasingly more areas of IT as they trigger re-engineering of processes and the upgrading or change of mission-critical platforms and applications.

1.1. ICT market size and structure

The Western European ICT market was 392 billion ECU in 1998, or 5% of GDP. Information technology (including office equipment, electronic data processing equipment, software, and services) accounted for 193 billion ECU, while telecommunications equipment and services contributed 199 billion ECU.

Western European ICT market growth was 8.9% in 1998, and is set to be 8.2% in 1999.

The European share of the ICT market accounted for 30.2% of the worldwide ICT market in 1998 (28.4% of the worldwide IT market, and 32.1% of the worldwide telecommunications market).

The ICT market grew 8.6% in the US in 1998. The Japanese market was particularly weak as a result of the financial crisis affecting Asia. ICT declined by 3.4% in 1998. The same situation characterised the ICT markets of the "Four Tigers" (South Korea, Taiwan, Hong Kong, and Singapore). Their combined market declined some 2.4% in 1998, but is expected to recover in 1999. The Rest of the World aggregate showed a positive dynamic, with ICT growing 15.0%.

1.2. Current market situation and prospects in Western Europe

1.2.1. IT trends

The Western European IT market showed an improving dynamic, reaching a 9.4% growth rate in 1998. 9.7% growth is expected for 1999.

i. Trends by country

Germany

The pace of GDP growth has strengthened in 1998 reaching 2.7%. Growth was more broad-based than in 1997, with domestic demand exerting more of a stimulus. The contribution of net exports, meanwhile, fell slightly.

The German IT market grew by 9.5% in 1998, and is set to grow by 10% in 1999.

Growth in the PC sector was driven by small and medium enterprises and government spending. Substitution of old technology in the con-

	1998 Value	1997 %	1998 %	1999 %
Europe*	207	28.4	28.4	28.6
US	319	43.3	43.9	43.9
Japan	91	14.1	12.5	12.1
4 Tigers**	19	2.9	2.7	2.7
RoW***	91	11.3	12.4	12.7
Total	**727**	**100.0**	**100.0**	**100.0**

Note: * Europe includes Western and Eastern Europe
** 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
*** RoW = Rest of World

Table 2
Worldwide IT market by region: percentage breakdown calculated on market values, 1997-1999, billion ECU

	1998 Value	1997 %	1998 %	1999 %
Europe*	437	30.2	30.2	30.1
US	518	35.5	35.8	35.7
Japan	164	12.7	11.4	11.0
4 Tigers**	49	3.9	3.5	3.5
RoW***	277	17.8	19.1	19.6
Total	**1,445**	**100.0**	**100.0**	**100.0**

Note: * Europe includes Western and Eastern Europe
** 4 Tigers = Hong Kong, South Korea, Singapore, Taiwan
*** RoW = Rest of World

Table 3
Worldwide ICT market by region: percentage breakdown calculated on market values, 1997-1999, billion ECU

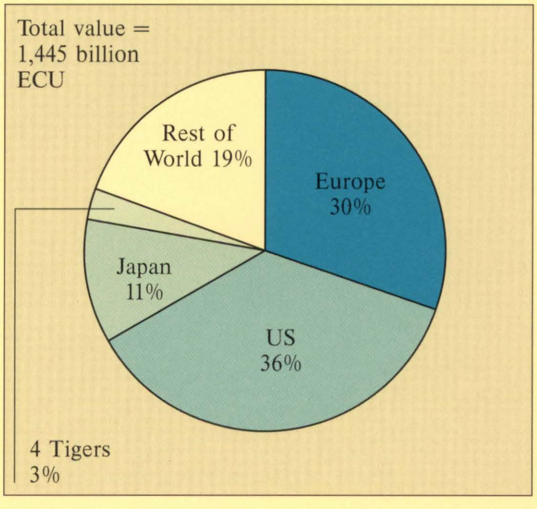


Figure 2
Worldwide ICT market by region, 1998

Table 4
Western European IT market by country: percentage breakdown and growth calculated on market values, 1998-2000, billion ECU

	1998 Value	1998 %	1998/97 %	1999/98 %	2000/99 %
EU	182	94.1	9.5	9.8	9.6
Germany	45	23.2	9.5	10.0	9.3
France	34	17.7	9.8	10.1	10.8
UK	40	20.9	9.8	9.8	9.9
Italy	16	8.5	8.3	8.3	8.7
Spain	7	3.8	9.5	9.4	9.8
Other EU	38	19.9	9.5	9.9	9.1
Non-EU*	11	5.9	7.3	8.7	7.5
Western Europe	**193**	**100.0**	**9.4**	**9.7**	**9.5**

Note: * Switzerland and Norway
Total and percentages may not add up due to rounding.

sumer base is stimulating growth in the home sector. The price war in the area of desktop PCs - which is the heaviest in Europe - is now expected to extend to notebooks.

Year 2000 and Euro conversion concerns have boosted sales of software and services, even if the Euro has so far not had the same impact on IT spending as the Year 2000. The Year 2000 problem had a substantial effect upon overall software revenues as many companies opted to purchase entire new systems developed with compliance in mind. A key trend is the growth in consulting and training services, as German companies take a more holistic approach to IT spending. Skill shortage has driven growth in outsourcing.

ERP (Enterprise Resource Planning) adoption rates continue to grow at a fast pace. The inclusion of medium-sized companies in the ERP vendors' target groups has now expanded the scope of business. This dynamic will also carry over into the small business segment as software vendors introduce new products for a Windows NT environment.

Internet commerce was an important market area for IT growth in 1998. Smart card technology is another area of growth in Germany.

France

The buoyancy of the domestic economy in 1998 is partly offset by a negative contribution from the trade balance, with export growth dampened by the gloomy world trade outlook. GDP growth was 3.1% in 1998. A further 2.4% increase is expected for 1999.

The resurgence in the French economy had a positive impact on IT growth that reached a 9.8% growth rate in 1998, and is expected to average some 10.1% in 1999.

Small businesses are driving PC market growth in France, while the home market is catching up with the other advanced European countries thanks to hard competition resulting in lower prices, and the opening of new sales channels (hypermarkets). Some shift from desktop to portables is expected depending on the competitive environment and price decreases.

In terms of access to the Internet, the French market could see a development in the area of Web devices in addition to the traditional PC platform. Devices which allow Internet access via television could be a major growth area, and French digital television operators have already begun to develop interactive services enabling customers to access the Internet.

The Year 2000 problem remains a crucial driver for software and services spending in France. In particular, as French government departments have dealt with compliancy issues particularly slowly, there is space for further growth in both segments.

Internet commerce has been slow to take off in France.

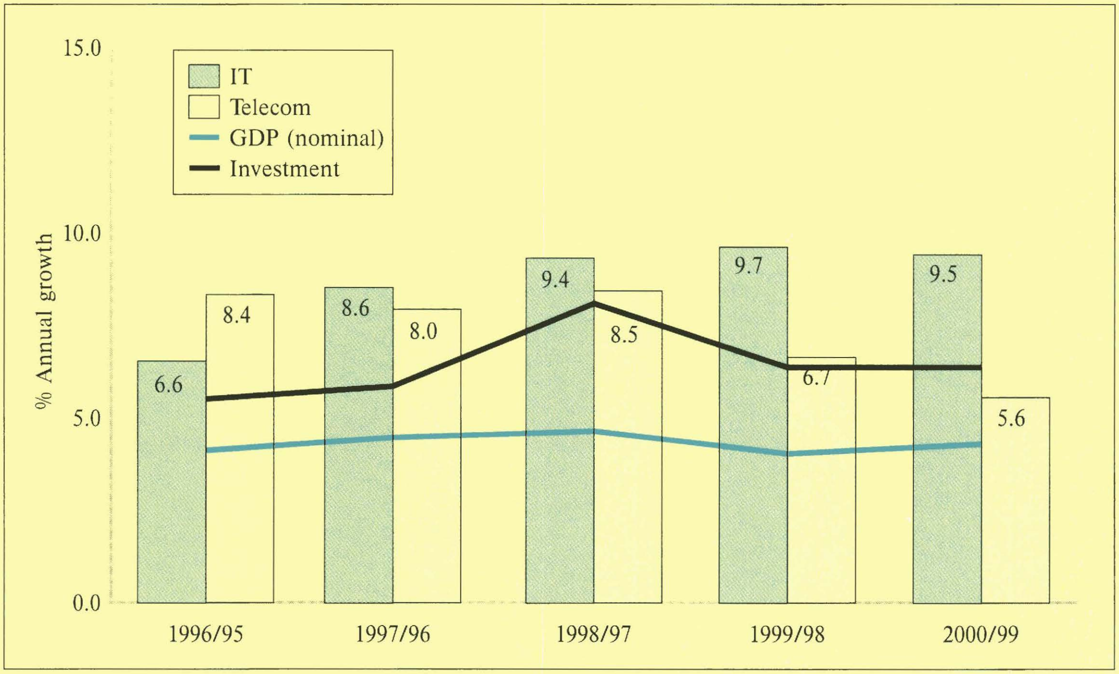


Figure 3
Western European GDP, investment, IT and TLC market, 1996-2000

UK

Real GDP growth slowed sharply in 1998 (2.7%) and is forecast to remain sluggish into 1999 (0.8%) before recovering from 2000 onwards. At the time of going to press, fears of recession for 1999 were increasing.

Despite the deteriorating economic environment, the UK IT market is confirmed to be strong, with a sustained 9.8% growth both in 1998, and 1999.

The PC sector remained flat in revenue growth as a result of the price war, and of dampened enthusiasm for investment because of high interest rates.

Growth in the PC segment is driven by increasing acceptance of the cost of ownership concept. While large company replacement rates accelerate thanks to lower pricing and belated migration to NT, aggressive strategies are targeting the small and medium-sized enterprises (SMEs). A three year investment in IT by government is driving growth in the education sector.

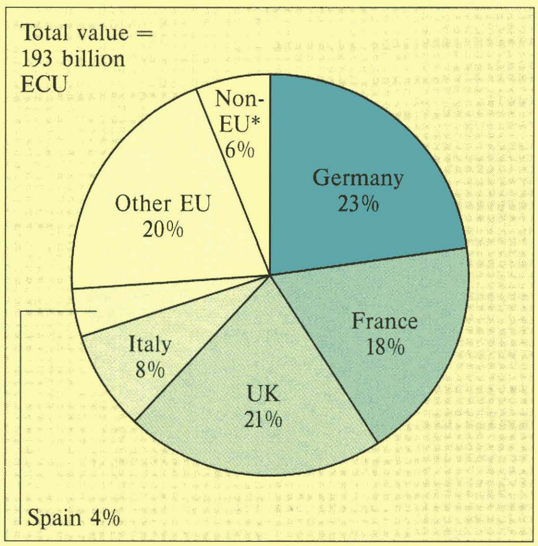


Figure 4
Western European IT market by country, 1998

* Switzerland and Norway

The IT services market is the fastest growing segment of the total UK IT market. Outsourcing is set to record slower growth in the short term while an increasingly positive performance is expected for network services. Consulting and training services are also important areas of growth.

Although the UK will not be part of the first wave of Monetary Union, Euro projects will be no less crucial than in the other Western European countries. Euro-compliance has long been a grey area, but UK businesses are finally waking up to the scale of the task ahead. Not least among drivers was the warning from the industry watchdog, the Financial Services Authority, that it might consider closing down banks that cannot prove their key systems are compliant.

Software as well as IT services vendors are expected to benefit from increasing demand for automated, quick-fix tools, especially for Year 2000- and Euro-enabled solutions, despite lack of certainty of the timing of UK participation.

The UK government is actively promoting E-commerce, including regulatory actions and the appointment of an E-commerce "envoy" to work at national and international level.

Italy

In 1998 economic growth was lower than expected (1.5%), due to low consumer spending. However, lower interest rates and government incentives to create new jobs and improve business climate suggest that GDP growth may accelerate in 1999 (2.1%).

The Italian IT market growth rate 8.3% was still below the European average in 1998. The same trend is expected to apply in 1999. The Italian IT market growth is driven primarily by investments by large enterprises. In the second half of 1998, the SME market has started to recover although users still remain very sensitive to prices. Further growth in the SME segment is expected in 1999. Investment is directed primarily to network infrastructure, data warehouse and ERP, and to services such as consulting, systems integration, network and systems management.

1998 has been characterised by price erosion in the Italian PC segment due to the highly aggressive sales policies adopted by the main vendors. Italian PC spending was still driven by medium and large accounts (especially in the automotive, and telecommunication industries), and directed mainly to desktop platforms. Improved consumer confidence, and higher availability of "edutainment" software boosted the consumer segment.

The Italian services market is slightly behind the other major European markets in terms of its level. The growth rates are improving as Italian businesses try to catch up with the other European countries. As in other countries, Euro and Year 2000 compliance are playing a significant role in driving growth in the Italian IT services market.

The ERP market with its double-digit growth confirmed its leading role in the Italian software segment.

E-commerce is slow to take off in Italy, but should accelerate quickly in the coming years.

Spain

Despite a deteriorating environment in world markets, the Spanish economy proved to be solid with GDP growing by 3.8% in 1998. In 1999, GDP growth is expected to be 3.4%. Although consumer confidence may be hit by the recent fall in equity prices, private consumption, supported by a continued rise in employment and by cuts in income tax, should continue to grow. Business confidence is also likely to be adversely affected by weak demand in emerging markets and by deteriorating sentiment in developed-country stockmarkets, but gross fixed investment should still grow at a steady rate against a background of solid domestic demand, high rates of capacity utilisation and low interest rates.

The IT market is expected to benefit from this healthy economic situation, reaching a 9.5% growth rate in 1998. 1999 is expected to see a 9.4% growth rate.

Businesses have potential to support PC growth until the end of the decade, with large corporations leading. The need to compete with large foreign businesses operating in Spain and first time investments from small businesses drove market growth in 1998. There has been a renewed interest from consumers in 1998, with low-priced PCs available through local assembly.

The move towards the single European currency is a significant driver in the Spanish IT services market as companies gradually realise the extent of the work needed to make their systems Euro-compatible. Year 2000 remains a central issue and continues to be a key driver in the IT services sector in 1999.

ERP and data warehousing are key areas of growth in Spain, and this stimulates not only the software market but also demand for related services.

Other countries

Economic prospects in the Nordic region remain good. IT growth was 9.4% in 1998, and is set to reach 9.7% in 1999.

In Switzerland, IT spending was weak in 1998 (6.5%), but it is expected to recover substantially in 1999 (8.6%). IT spending in Austria was 8.8% in 1998. The same trend (8.9%) is forecast for 1999.

Belgium recorded an higher than average IT growth rate in 1998 (10.1%). A further 10.4% improvement is expected for 1999. The Dutch IT market enjoyed a 9.0% growth rate in 1998, and is expected to reach 9.6% in 1999.

The Irish IT market continued to perform above average, reaching a 10.3% growth in 1998, and is set to keep the same pace in 1999 (11.0%). Greece is experiencing a strong recovery in IT spending (11.7% in 1998, and 12.7% in 1999). The IT market in Portugal reached a 9.5% growth rate in 1998, and is set to grow a further 9.4% in 1999.

ii. Trends by product segment

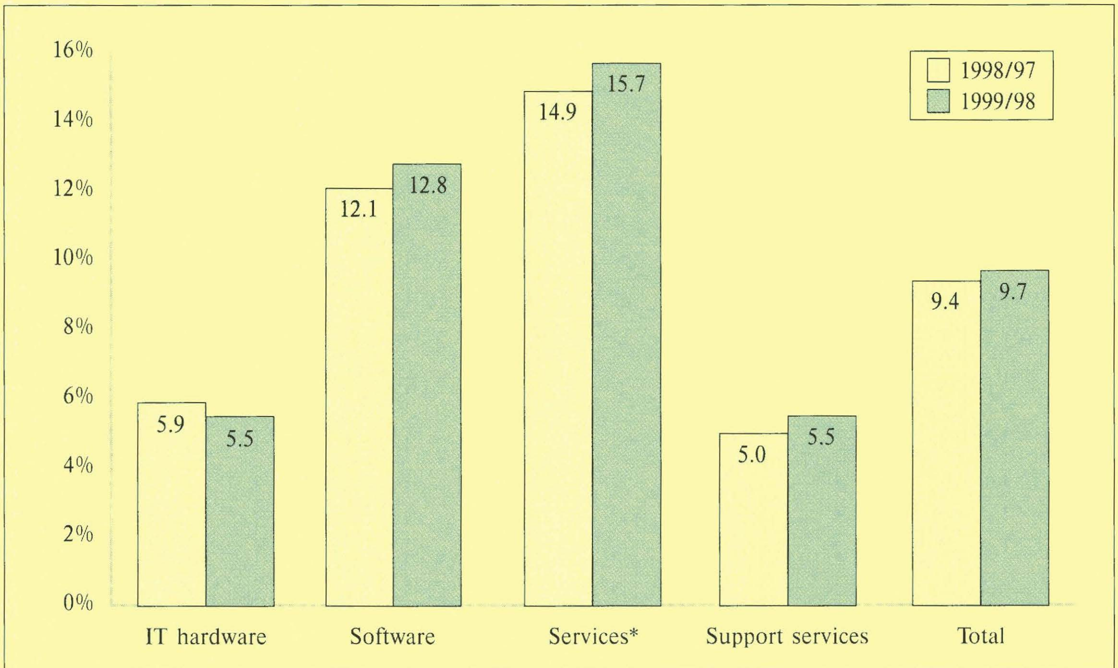
IT hardware

The IT hardware market grew by 5.9% in 1998, and a 5.5% performance is expected for 1999. This growth was boosted by a good performance in the server and PC client segments.

The Western European server market grew by 8.0% in 1998, and represented 29% of the total IT hardware market (28% in 1997). Both the introduction of the Euro and the Year 2000 issue are leading to greater investments in servers. The shift towards smaller systems and the use of merchant chip types have created an expectation of rapid annual improvements in price/performance in the server area. This in turn is shortening the average life cycle of servers and making the market more like the PC area, increasing annual sales as a result.

Overall, Unix is expected to keep a large share of server operating environments (in terms of customer revenues), reaching a 38% share of the total server market (excluding add-ons) in 1999. Unix's strengths are particularly evident in the midrange server segment, supporting leading-edge database products, highly available solutions, strong application development tools and comprehensive client/server application solution packages. Unix will remain

Figure 5
Western European IT market value growth by product segments, 1998-1999



* Services include: consulting, implementation and operations management services.

the leading operating environment within high-end decision support and Internet applications. NT servers are expected to grow significantly, and to reach 20% of the total server market (excluding add-ons) in 2000. The demand for conversion to 64 bit is keeping pace with the functionality requirements of network services and data-centric layers of computing, and will force many operating system providers to abandon future development on proprietary platforms in favour of NT or Unix.

Although the *high-end server* (more than ECU 885,000) market shows a declining trend from 24% share of the server market in 1997 to 21% in 1998, shipments are still increasing. The reason for this is the final stages of migration from expensive bipolar technologies to CMOS-based processors.

The high-end server market is increasingly characterised by improving performances and availability, especially for the commercial data-processing segment, to run the mission-critical business processing applications in large organisations. OLTP (On-Line Transaction Processing) applications still dominate, but an increasing number of organisations are moving to ERP applications, which mainly run on Unix. Servers for these applications tend to be built on symmetrical multiprocessing (SMP) designs. Other drivers for the adoption of high-end servers are the development of Intranet and Web server applications, data warehousing and the consolidation of servers, particularly within the Unix platform.

Midrange servers (between ECU 88,500 and ECU 885,000) are showing the strongest growth, and are expected to represent some 34% of the total server market (excluding add-ons) in 1999. While the low-end server (less than ECU 88,500) area is being taken over by Intel-based machines, Unix vendors find increasing acceptance in the midrange server area. Windows NT is expected to make slow progress initially in the midrange server marketplace. Enterprise

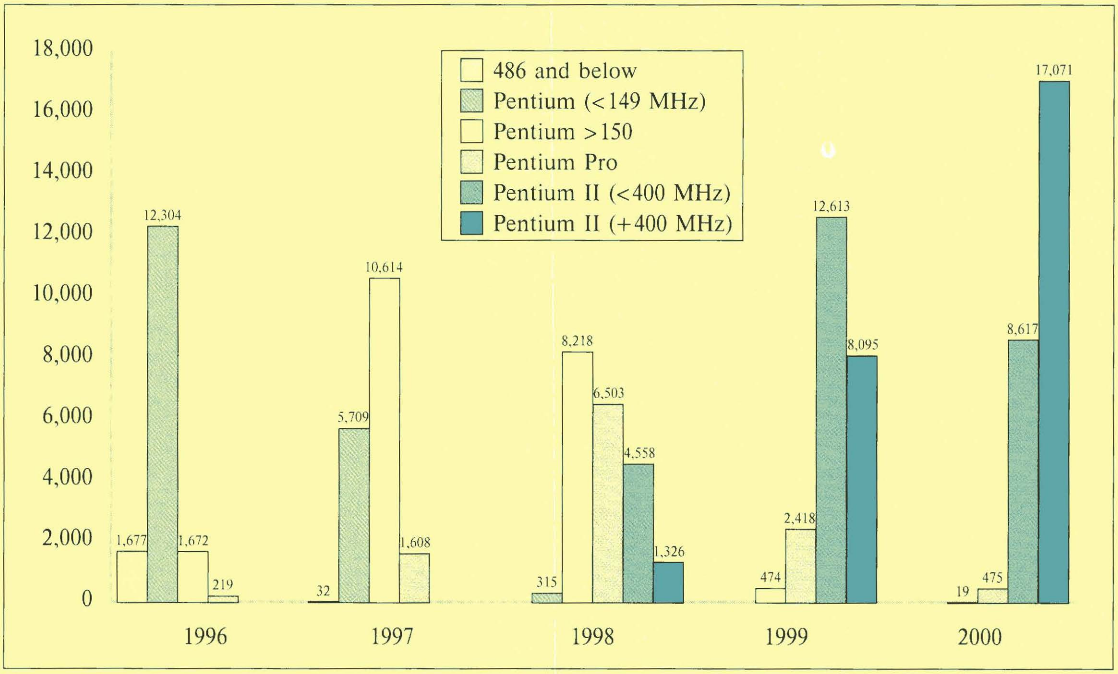


Figure 6
Western European personal computer market, 486 systems versus Pentium, Pentium Pro and Pentium II, 1996-2000, unit shipments (thousands)

users are expected to be cautious, and application growth will be generated by new applications rather than by migration from existing applications. NT servers will be challenged to provide the reliability and performance to compete with Unix and AS/400 for midrange mission-critical applications. However, NT servers are expected to dominate the midrange server market for collaborative services (particularly e-mail systems).

In the *PC market,* the low-cost desktop market assisted in the resurgence of the consumer market, as low price points continued to attract end-users across Europe. As 1997, 1998 brought excellent growth for the business segment in unit shipment terms. Overall, the PC market grew by 5.0%, representing 36% of the total IT hardware market, slightly below the level in 1997. However, falling prices both for desktops and portables, anticipated saturation of the large business segment, and expected competition from other client devices (Enterprise NCs, Windows terminals, network/web applications) are posing a threat to the value growth of the market.

PC market accelerators include:

- desktop upgrading in large/medium enterprises to Pentium II/NT;
- Year 2000 and Euro issues hastening upgrading of PCs in large organisations;
- ERP software supporting general growth;
- Web PCs sales;
- targeted marketing campaigns encouraging SMEs to upgrade.

The *desktop PC market* grew above expectation in 1998 both in units and value terms, reaching a 76% share of the total PC market.

The expected widespread replacement of desktops with portables has failed to materialise, nor have the NC and NetPC emerged as a near-term threat to the desktop.

After a disappointing 1997, the Western European market for portable PCs increased its pace of growth in 1998 mainly thanks to a replacement market scenario with demand for Pentium II-based configurations.

Flat-screen technology has yet to storm the market, but it is putting considerable pressure on conventional cathode ray tube (CRT) pricing. Demand for flat-screen technology is now limited to those areas where the monitor requirement is application-driven, such as reception desks and trading floors. CRTs have better refresh rates, more functionality, higher resolutions and bandwidth, and are significantly cheaper than their flatter rivals. Moreover thinner CRT technologies are starting to emerge. So, in the medium term, they will continue to be the best price-to-performance products. However, sales of flat screens are expected to accelerate as pricing becomes more competitive and product feature sets start to drive purchasing decisions.

A big threat to home PC shipments is expected to come from the development of the information appliance market (e.g. Net TVs, screenphones, Internet gaming consoles, Internet smart handheld devices). During 1998, the information appliance market has been poised on the edge of mass-market acceptance. Although information appliances represent some 2% of total Internet access devices in Europe, strong growth is expected through 2002 as they fill the market opening for easy-to-use, low-cost access to Internet-based benefits. In 2002, shipments of consumer-used information appliances are expected to outstrip those of consumer-used desktop PCs.

The market for traditional workstations continued to decline in 1998 (-7.4%). This market is mature. Most unit shipments came from replacement. Incremental growth was recorded in some small, but emerging, very competitive segments, such as animation.

The market for *printers* is affected by differing trends. Overall, inkjet technology continues to dominate the market accounting for 74% of all printer shipments in 1998. The monochrome inkjet segment is declining with no new models introduced, and increasing competition from colour inkjets. The colour inkjet segment is experiencing strong unit growth thanks to competitive prices, improved speed and print quality, appealing also to the home and small business sectors of the market. Low-cost colour inkjet products continue to invade the dot matrix and personal monochrome laser printer markets, resulting in lower shipments in both technologies. Dot matrix's appeal is confined to a small area of the printer market for those requiring devices that are durable pieces of equipment for heavy-duty environments and for specialist applications. Lower prices for desktop colour laser printers will result in competition at the low end with colour inkjet printers.

Powered by a growing need for corporations to improve management of their internal knowledge assets, emerging new copier technology combines the functionality of scanners and printers to emulate the standard office copier, and connects all hardware devices to the enterprise printers, scanners, and digital copiers. With browser-based applications, the gap is bridged between hard copy and electronic documents, providing users with a unified system for paper processing. By linking departmentally-networked and stand-alone office equipment via an intranet, this technology enables such functions as copying, printing, scanning, e-mail and fax from the PC to any output device, speeding business processes.

	Germany	France	UK	Italy	Netherlands	Western Europe
Manufacturing	74.6	74.6	81.0	79.0	89.8	77.4
Transport/communication/utilities	69.1	77.2	89.9	85.6	89.5	79.1
Retail/wholesale	89.3	88.4	88.9	75.0	73.1	87.7
Finance	100.0	85.1	95.7	87.4	96.7	93.2
Government	100.0	92.1	93.9	93.8	100.0	97.3
Education	94.0	86.5	97.3	82.3	100.0	90.6
All industries	**84.9**	**75.3**	**88.8**	**81.2**	**87.8**	**83.7**

Table 5
Presence of LANs by vertical markets, 1998, % of sites which are using Local Area Networks (LANs)

Internet connectivity, and intranet deployment continued to be the major drivers for *datacommunications equipment* demand. LAN switching is predicted to be an enormous growth market. Today, a major part of switching ports is used for workgroup and backbone connectivity, but desktop switching is expected to become more important in the near future. 10/100 Mbps Ethernet switching will become the largest shipping technology by 1999, all at the expense of 10 Mbps shared Ethernet technology. All other technologies (Gigabit Ethernet, Token Ring, FDDI, and ATM) will remain relatively small compared with switched 10 Mbps and switched 10/100 Mbps Ethernet. The growth in the LAN hub market reflected strong performances in the 10/100 Mbps Ethernet segment and within fixed port configurations of shared hubs. The modular segments all showed further declines caused by the refocus of the market on the smaller business segment and inroads from switching technology. As concerns the router market, the low-end and midrange segments of the market continued to grow, while the high-end segment contracted slightly as the market started to approach a saturation point. The high growth in the low-end segment was driven by two main factors: small businesses connecting to the Internet and the growth in branch office networking. The midrange market was impacted by Layer-3 hardware switches, which are increasingly used to replace routers. The 56k modem dispute that characterised 1997 has created a lot of uncertainty in the modem segment. This uncertainty also slowed down the upgrade of Internet service provider (ISP) dial-in equipment. With the final V.90 standard in sight, 1998 was a better year in this respect, although there was still not a full interoperability among proprietary technologies. However, as end-users' demand for bandwidth rises, dissatisfaction among analogue modem users will eventually drive them toward newer access technologies.

The *office equipment* market continued to show a flat dynamic in 1998 (1.3%). A boost is expected to come from the spreading of teleworking in Europe, as well as the growth of home PCs. As the number of people working at home increases, opportunity will rise for capable home/office machinery, especially for multi-functional peripherals able to combine three or more of the following functions: printing, copying, faxing, and scanning.

Software products

Software sales rose by 12.1% in 1998, and are set to grow by 12.8% in 1999. The Western European software market benefited above all from the changes in the business environment.

The Western European economy was characterised in 1998 by a strong trend towards globalisation involving major companies' requirements:

- increasing geographic coverage of the business;
- exploiting advantages from diversity in customer base;
- increasing the pace and efficiency of the business environment.

These requirements are significantly accelerated by the Internet. Intranets started to become information access and groupware backbones for global expansion, while extranets represented the basis for federated supply chains.

The globalisation of businesses has called for the integration of applications. Increasingly, distributed enterprises needed their backoffice functions to integrate, and enterprise suites have faced the multiple challenges of distributing the solution across heterogeneous platforms, enabling increased data access, running in a networked environment, and replacing their legacy systems with modern functionality. As business extends its geographic scope, customer intimacy is crucial for successful competition. This trend has driven demand for electronic design, manufacturing, distribution, and supply-chain planning and integration software, but also for datawarehousing, DBMS (Database Management Systems) engines and associated tools, as well as middleware to automate data collection. In addition, the goals of customer intimacy and efficiency require the modernisation of front-office functions. So as back-office systems are brought into Year 2000 compliance, software spending will focus on the automation of customer support, help desk, sales, marketing, and customer life-cycle management.

Issues related to staff resources have also driven software demand. The labour shortage has impacted the software industry in two ways:

- the drive to software based on components developed for network computing standards and characterised by a strong focus on business processes;
- the redefinition of the offering of software products to include vendor partners that supply product-specific implementation and operation knowledge.

A further boost for the software industry is expected to come from the development of the information appliance market. A new breed of software developers is expected to emerge, while OS (Operating System) providers in turn are expected to offer software developers new development kits for application creation.

The following trends characterise the *application solutions* segment:

- Enterprise application vendors have started to target the middle market with pre-packaged, pre-configured solutions for small and medium enterprises.
- Demand for software to support integrated business processes will continue to drive the market.
- Adding analytical capabilities and building "best practice" in software solutions to specific vertical segments are other major requirements in the sector.
- The goal of customer intimacy and cost efficiency has triggered growth in the front-office applications market. Sales force automation, customer support and help-desk applications are leading to the integration of front-office applications with complex back-office applications.
- The impact of the Year 2000 problem is increasing, especially in SMEs, greatly encouraging companies to abandon proprietary software and migrate to standard applications.

- The Euro has failed to attract the headlines in the same dramatic fashion as the millennium, but remains a very critical issue nonetheless.
- Internet-enabling application solutions has so far meant providing access over the Internet. Many application solution providers are preparing to enable the application server to the Internet by developing their applications in Java or encapsulating the present application in Java, and early versions of these products started appearing on the market in late 1998.

In *system software* a resurgence is expected with respect to the scalability, availability, and reliability capabilities of the mainframe environments in running the critical corporate applications. As business-critical applications using one-tier and two-tier client/server architectures continue to be rolled out, companies have been forced to address some of the issues of system management more carefully to achieve the desired levels of availability and performance.

Some other important trends are:

- Groupware and e-mail solutions are becoming more important parts of the IT infrastructure. This situation is driving the development of applications to assist in the deployment, administration, backup, and availability management of these tools.
- The problem of managing desktop assets continues to create opportunities for ISVs. The maintenance of client-side application code, and of ensuring consistency of machine configuration, on highly dispersed and highly disparate client platforms is creating increased interest in change and configuration management tools, especially in electronic software distribution. The so-called network computer (NC) and the so-called zero-administration client are both alternative methods of addressing this problem, and the success of either or both of these concepts may well have a major impact eventually on this part of the market.
- The concept of the business-oriented view of system management as a supplement to the traditional system- and network-oriented view is now well established. As part of this trend, the emphasis on systems performance and availability monitoring applications has shifted from the initial focus on systems and databases to include the applications themselves. Most recently the emphasis has been extended to middleware.
- Middleware will focus on delivering greater ease of use, while businessware will emerge as a new class of software products targeted at delivering one or more of these value propositions: eliminating the island of automation with application integration, energising business operations with event-driven processing, and automating the enterprise with business process automation. Businessware is therefore targeted at unifying the business.

As regards the *applications tools* segment, database technology will experience price pressure as it saturates the large enterprise and goes down the market. DBMS fortune is however expected to improve dramatically as rich content and complex schemes of strategic Internet-enabled applications come to drive the growth of object and object-relational DBMS. Components are the organising principle of tools, while functionality is becoming more and more sophisticated with the development of life-cycle management and the inclusion of multimedia capabilities.

IT services

1998 was a great year for IT spending in the services sector. IT services including support services grew by 12.5% in 1998. The Euro issue continued to have a major influence on business and IT services in 1998. So far, Euro-related services have for the most part focused on the early stages of assessment, planning, and awareness training. Increasingly, implementation work will become the main focus and remain so for a few more years until about 2002. But for several years from now there will be a mix of opportunities for Euro-related consulting and implementation services.

The emergence of packaged client/server software has broken new ground on the services market, especially the systems integration segment.

The demand for *consulting services* is linked to economic trends, technology advances and consumer needs. The following major trends impacted consulting services in 1998:

- the *Euro* as a major source of consultancy work as countries seek to co-operate with deregulated markets;
- *technology issues* including the Year 2000, the establishment of external Web sites or of an intranet, and E-commerce;
- *globalisation* involving assistance of both business and IT consultants in areas including organisational structure, IT strategy, marketing and communications, and logistics;
- *deregulation,* in several industry sectors, mainly telecommunications, financial services, transportation, and utilities, accompanied by increasing competitive pressures, leading to a strong demand for consulting services - business and IT consulting alike - as companies re-examined their business process;
- *mergers & acquisitions* changing the competitive environment, and making information the foundation to achieve competitive advantages. In light of the fact that Europe is "overbanked," the financial services industry has proven to be a good bet for consulting firms as banks continue to seek out suitable partners or targets. Mergers are also on the rise in the insurance, beverage, publishing, and pharmaceutical industries. The "strategy" consulting firms will reap the benefits of this trend, as will the IT consultancies, because consolidation involves business as well as technology considerations;
- vendors' focus on the small and medium sized segment of the market as SMEs have started increasingly to ask for IT;
- *ERP* implementation involving enterprise-wide changes, and increasing demand for process improvement, project management and change management consulting services.

Companies' need to revise their information systems to compete in a global environment, and technology complexity have continued to be major drivers for the *implementation services* market. E-commerce, workgroup applications, the Internet and the move to intranets, along with ERP systems, are expected to continue to support the demand for implementation services. The need to integrate and automate the business value chain is expected to be another major driver.

Prospects for external system integration remain excellent. Decreasing technology cycles, improving expertise and the expansion of organisations across country boundaries have continued to support the need for increased specialisation. Specific industries in Europe are also under competitive pressure due to deregulation. At this time, the communications and transportation industries are aggressively investing in new technologies in order to remain competitive.

The Western European IT training and education segment will grow at a healthy rate as companies realise the need to invest in the technical skills necessary for employees to perform their roles effectively and to keep those skills up to date. The major restraining factor on market growth has been customer concern about the expensive and time-consuming nature of training activity. The advent of sophisticated, self-paced, technology-based products brings a potential solution to these problems, allowing training to be undertaken more flexibly, more cost- and time-effectively and with more measurable results.

The move towards distributed processing environments and client/server has made the management and support of a company's IT asset increasingly difficult, favouring the growth of *operation management* services. Growth has also been boosted by outsourcing fuelled by shortage of skilled human capital, privatisation and deregulation pressures, emerging technologies such as the Internet, the change to Euro, and structural changes in companies' value chain. The emergence of a new class of application that leverages the power of the Internet is set to require a class of tools for Web operations management to manage performance, availability, reliability, security, and content distribution.

The trend towards outsourcing IT functions has increased rapidly in recent years and is set to continue, especially among large user organisations, particularly for sites requiring the implementation and ongoing maintenance of ERP systems. Business process outsourcing (BPO) represents the smallest outsourcing service type, but the one with the highest growth for the coming years, showing a CAGR of 22.8% through 2001. The area of network outsourcing is also set to increase very rapidly. Dramatic growth in network outsourcing will see the network services industry dominated by franchising, remote management and complex virtual companies. However, outsourcing may begin to level out in some countries such as the UK where many companies which have outsourced IT are now looking to make no more changes, and a smaller number are taking some of their IT functions back in-house. A lack of in-house IT skills, rather than cost, remains the main reason companies are opting for IT outsourcing services.

Enterprises are becoming increasingly dependent on complex IT configurations which underpin their business processes, and a rapidly growing proportion of mission-critical business processes are supported by IT. The need to have no interruptions to business processes is driving growth for high availability services. High availability services can be defined as a set of services which seek to ensure that IT environments, which are perceived to be mission-critical, remain operational. The growing use of Internet technology to support electronic business infrastructures, distributed IT environments, the increasing use of integrated businesses applications, and the emergence of Windows NT in the enterprise are all driving demand for services of this kind.

1998 saw a strong decline for hardware *support services,* while software support continued to perform well mirroring the growth in the software market. Telephone support continued to represent the largest activity segment, followed by software maintenance. Despite the larger current market shares enjoyed by these service activities, the fastest growth rates occur in other segments. Electronic support is increasing the fastest, followed by predictive/preventive maintenance, remote diagnostics, and software update management. These fast-growing services reflect the importance of support technologies that enable an emerging proactive, self-service support model, as opposed to the current reactive one.

Table 6
Western European telecommunications market by region: percentage breakdown and growth calculated on market values, 1998-2000, billion ECU

	1998 Value	1998 %	1998/97 %	1999/98 %	2000/99 %
EU	189	94.9	8.6	6.7	5.6
Germany	44	22.2	5.5	4.5	4.0
France	30	15.2	9.9	6.3	5.5
UK	33	16.6	5.4	4.9	4.6
Italy	28	13.9	14.6	9.9	8.1
Spain	12	6.2	9.7	11.1	6.3
Other EU	41	20.8	9.6	7.4	6.2
Non-EU*	10	5.1	7.3	5.6	4.8
Western Europe	**199**	**100.0**	**8.5**	**6.7**	**5.6**

Note: * Switzerland and Norway
Total and percentage may not add up due to rounding.

1.2.2. Telecommunications trends

The Western European telecommunications market grew by 8.5% in 1998 reaching 199 billion ECU. 1999 will see a further growth of 6.7% to 212 billion ECU.

Growth in the sector has continued to be driven by liberalisation across Europe, and new products, in particular the broad data category (Internet) and mobile telecommunication.

i. Trends by country

Germany

Growth in the telecommunications market was 5.5% in 1998 and is expected to be 4.5% in 1999.

German telecommunications traffic is set to increase both in the fixed-line and mobile services segments. After having started to catch up in 1997, the mobile telecommunication services market will continue to grow in 1999. Germany will be Europe's second-largest market in terms of mobile net subscribers.

The growth of ISDN (Integrated Services Digital Network) has been boosted by low tariffs and Deutsche Telekom's promotional action that is offering low-cost plug-and-play ISDN packages that include the ISDN terminal equipment. Germany will remain the largest market for ISDN in Europe though its overall share will decline as ISDN is increasingly taken up across the continent. Germany also leads the way in fibre optic infrastructure across Europe.

ADSL (Asymmetric Digital Subscriber Lines) will be lauched in 1999 by Deutsche Telekom in metropolian areas as a regular service but it is still far away from achieving a significant portion of Internet access.

The opening of Germany's telecommunication market to full competition was completed in January 1998. Service providers have been competing for business clients for quite some time, and this is the area where competition remains the strongest.

Deutsche Telekom is still the dominant phone company in Germany, but is steadily losing market share to competitors especially to a host of local city and regional carriers. The pressure of price competition is being piled up by the "call by call" system, which allows users to select the carrier simply by dialling a prefix before the recipient's number. Because of this, the prices for national and international calls will further decline. By 1998, Deutsche Telekom's investment toward "Telekom 2000" – a massive programme to construct a modernised infrastructure throughout the new states in the Eastern part of Germany – has reached an impressive ECU 49 billion.

Wider acceptance of Internet telephony is expected in Germany, with the involvement of all major telecommunications players and media giants, leading to improved quality and a further price reduction of products and services.

Their increased efforts to market Internet telephony in Germany include offers to attract private users and small businesses with communication costs 40% below the rates of the traditional carriers. Germany's large utilities are experimenting with electricity transmission lines as an alternative to traditional telecommunication lines for both voice and data. Two large utilities GEW and HEW are the owners of the telecommunication city networks in Cologne and Hamburg, respectively, and have a vested interest in cost-efficient alternatives for the "last mile" connection.

France

The French telecommunications market grew by 9.9% in 1998 and is set to grow by 6.3% in 1999.

Growth in the French telecommunications services market was driven by the mobile segment. The fixed-line telecommunications market saw a drop in revenues in 1998 as a consequence of falling rates for the efforts of rebalancing fixed telephony tariffs. Revenue decline in this segment was compensated by a boom in Internet traffic and strong growth in Internet access service.

The mobile services market continued to outperform during 1998, with strong increases in both subscriber base and revenues. As the French mobile penetration rate remains relatively low, a further increase is also expected for the years to come.

Despite tariff reductions, the high growth in lucrative fixed-to-mobile calls as well as the strong demand for ISDN connections will maintain healthy growth in the PSTN (Public Service Telephone Network)/ISDN market. Although the residential market will continue to expand, the business sector will not exhibit the same level of growth as in other countries.

France is the second largest market for ISDN, after Germany. However, the primary method to provide Internet access remains dial-up modem.

The French fixed-line telecommunication market was open to full competition at the beginning of 1998. The French government has reduced its stake to 62% in December 1998.

Pre-existent delays in interconnection will have an impact on all new operators.

United Kingdom

The UK telecommunications market experienced a 5.4% growth rate in 1998, and is expected to grow by 4.9% in 1999. The market is intensely competitive. An indicator of this is that industry regulator Oftel has awarded over 400 licences for a variety of services including fixed and mobile, by various types of operators including for example traditional players, cable companies and simple resale companies.

The UK fixed-line telecommunications market has continued to register strong growth in call volumes, with, for example, industry leader BT's international and domestic call volumes up by, respectively, 7% and 9% in the financial years 1997/98. The UK mobile services market continued to show double-digit growth rates for both subscribers and revenues, and 40% for call minutes. A further boost to this segment is expected to come from further price reductions, the introduction of prepaid services and new marketing and channel strategies.

ISDN use and growth in the UK remains low compared with Germany as tariffs are still relatively high.

Further growth stimulus (e.g. in Internet usage) is expected to come from the launch in 1998 of new digital television channels.

BT is still the dominant phone company, but is steadily losing market share to a host of competitors including Cable & Wireless, cable TV companies and many international companies. BT's market share has declined most in the business market for international calls. However, BT still operates about 85% of all fixed PSTN lines. BT now has to reformulate its strategy after its plan to acquire MCI and form a global telecommunications company, known as Concert, failed. Subsequently, BT made an agreement to form a joint venture with AT&T, providing data, voice & video services globally.

Italy

The telecommunications market in Italy continued to perform very well reaching a growth rate of 14.6% in 1998. A further increase of 9.9% is expected for 1999.

With the cost of long-distance calls above the European average, call-back and international discount telecommunications services should hold good opportunities until competition develops. The Italian mobile services market became the largest in Europe in 1998, overtaking the UK. The subscribers base grew impressively, and Italy is now second only to Nordic countries in terms of penetration rate. Low tariffs, new products, promotions and marketing strategies have sustained this growth.

Although call revenues will grow at a very slow pace, due to significant tariff reductions over the short to medium term, increases in PSTN rental prices as well as the increase in ISDN channels will push overall PSTN/ISDN revenue growth.

The data transmission/Internet segment is expected to grow rapidly. The penetration of the Internet in Italy is still below the European average: many small and medium-sized companies have not yet invested in Internet technology and also the residential market is lagging. However, tariff reduction and promotional packages offered by large and small ISPs competing in this market are rapidly attracting the interest of new Internet users. There is a general consensus that in the next few years the use of the Internet will dramatically accelerate, sustaining demand for telecom services.

More intense use of ATM services will fuel overall growth in data network services, while tariff reduction will limit growth in the leased line market.

Italy's telecommunications market, lagging liberalisation in most of the other European countries, is now finally opening up to new competitors. At the end of 1998 there were 18 licensed operators (with 23 licences in total) in the wireline telephone sector and 3 operators in the cellular market (a fourth operator might be allowed to enter the market in 1999).

The regulatory aspect still represents one of the key issues in Italy. The authority, which became operational by mid-1998, has managed a crucial issue like the definition of a new interconnection price list; but many other key problems are still on the table, such as number portability, unbundling of the local loop, equal access, and the confrontation with the European Commission about the abolition of the licence fee payed by the carriers.

Spain

The Spanish telecommunications market grew by 9.7% in 1998, and is expected to reach an 11.1% growth level in 1999.

In the past three years, competition has stimulated growth in an extremely rapid way in the Spanish mobile services market. The mobile services market is set to continue to grow steadily, reaching more than 15 million subscribers in 2002.

Tariff rebalancing will lead to a significant shift in the Spanish PSTN/ISDN market away from long-distance and international call revenues, towards local call revenues and line connection and rental fees. Nevertheless, the international call market will experience fast growth as a boom in call traffic, fuelled by a generally strong economic growth, will more than compensate for falling tariffs. The leased line market will see strong growth over the next one or two years, though this will fall considerably towards the end of the forecast period as ISDN and ATM services begin to generate significant revenues.

ISDN usage is set to grow. Telefonica has started to provide discounts of up to 25% on tariffs for companies' inter-provincial traffic also for ISDN lines.

Spain's telecommunications sector opened to full liberalisation on December 1, 1998. Spain agreed to a special deal with the European Union which allowed it to extend the deadline for opening its telecommunications market for almost a year longer than most of Europe. After a period of frenzied activity in the sector and the start of services by basic operator Retevision in January, the third fixed-line operator, Lince started its service (Uni2) in December.

Retevision, the second fixed-line operator and the third mobile operator, is expected to launch its own digital telecommunications platform to compete with the two currently in existence in Spain: Via Digital, and Canal Satellite.

Other countries

In the *Nordic* region, fixed network voice revenues continued to grow only slightly, with fixed-line subscriptions remaining almost constant. The high penetration of mobile telephones and strong competition did not prevent growth in mobile voice revenues. The main 1998 growth areas are in sales of ISDN broadband connections, Internet and related data services, and added-value services.

In *Switzerland,* fixed network voice revenues kept growing, favoured by the slow development of competition in the first half of 1998. Strong demand for mobile voice services, and ISDN have also generated services revenue growth.

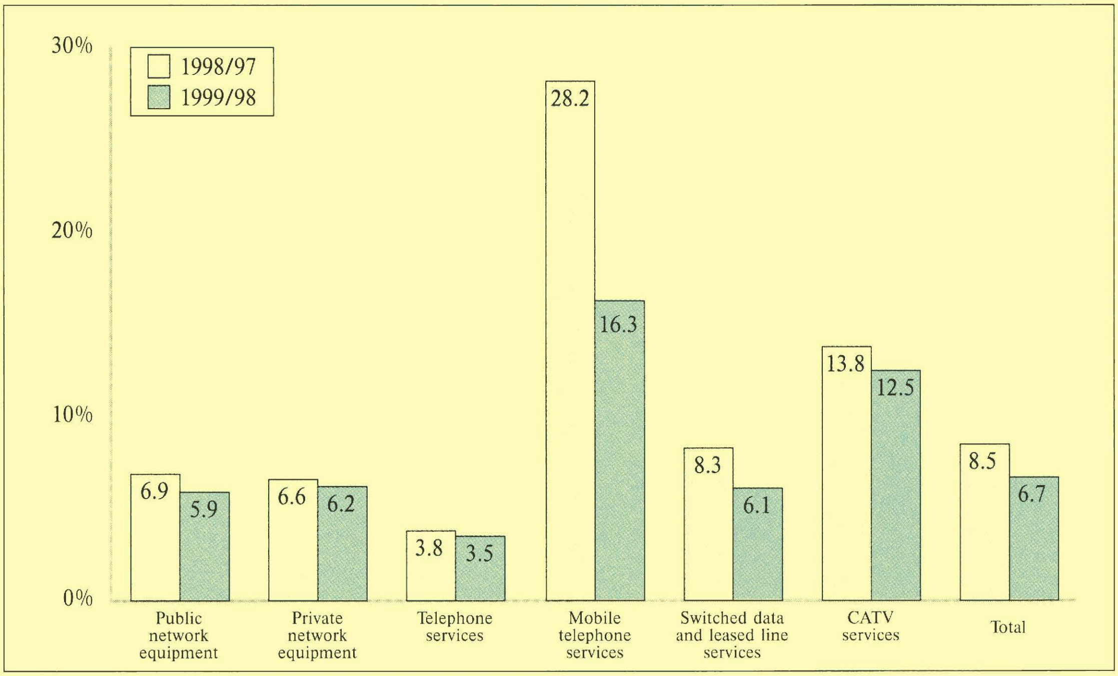
In *the Netherlands* and *Belgium,* competition continues to bring down tariffs impacting local and national call revenues, while mobile voice revenues maintain strong growth. However, price increases for PSTN line rental and the phenomenal growth of ISDN will keep overall PSTN/ISDN revenue growth high over the next two years. The leased line market will remain more or less static while data network services are experiencing a boom as ATM services are deployed across metropolitan areas.

Austrian telecommunications services 1998 growth came from a rapid increase in mobile call revenues and data services. A special price plan for small and medium-sized companies launched by Mobilkom in mid-August offered a better price for companies with five handsets or more. Increased investment in mobile phone networks is expected with Connect Austria entering the mobile market.

The *Irish* telecommunication market grew in 1998, driven by increasing business activity as well as tariff reductions on long-distance calls. These were applied in the end of 1998 to both business and residential customers in order to enhance the country's attractiveness to business. Telecom Eireann has plans for an initial public offering in the first half of 1999.

In *Portugal* and *Greece,* the telecommunications market showed continuing strong progress in 1998. Mobile telephony showed a steady growth, and new tariffs ensured increase in fixed-line traffic. ISDN demand also accelerated.

Figure 7
Western European telecommunications market value growth by product segments, 1998-1999



ii. Trends by product segment

Telecom equipment

The Western European telecommunications equipment market recorded a 6.7% growth in 1998, and is expected to grow by 6.1% in 1999.

Market developments in telecommunication equipment are driven by three strategic directions with a profound impact on telecommunications equipment users:

- IP (Internet Protocol) technology is increasingly being employed in telecommunication networks;
- the data communications industry is beginning to adopt the standards of robustness and high availability that have long characterised telecommunication or "carrier-class" networks;
- mobility, or wireless access, is an increasingly powerful force that will infuse all areas of communications from wireless LANs (Local Area Networks) in homes and offices, to wireless Internet access. Many of these applications will also be based on IP technologies and will require carrier-class networking know-how.

Telecommunication equipment suppliers have made strong efforts to integrate all three dimensions in their products and services. They are building their product portfolio to integrate as many IP capabilities as possible. IP router technology is now being implemented in the new generation wireless systems. Cellular technology, meanwhile, is being exported to Local Area Networks. Intelligent Network services have migrated to mobile systems.

Public network equipment

The *public network equipment* market grew by 6.9% in 1998, and is expected to improve further in 1999 showing a 5.9% growth rate.

In the fixed access area, public equipment suppliers plan to play a big role supporting telecommunication carriers that are upgrading ageing, land-based phone systems. They are focused on providing technology for carrying Internet traffic over standard phone lines and emerging broadband networks. Their efforts are geared towards transforming the ordinary, circuit-switched, fixed lines, by combining the reliability and guaranteed service of traditional networks with the cost efficiency of the Internet.

The possibilities of selling advanced equipment to new and existing operators are compensating for decreasing prices generated by technological advances.

Public telecommunications equipment demand is growing for:

- intelligent networking technology and equipment to alleviate congestion from online services and Internet usage;
- remote access applications and surveillance applications using ISDN;
- systems for carrier networks to handle provisioning, maintenance and billing processes;
- new generation ATM (Asynchronous Transfer Modem) switches to handle switched virtual circuits.

Much of the future demand for public network equipment is expected to come from wireless voice and wireless data. Various drivers contribute to increasing the usage of wireless networks:

- decreasing service and equipment costs for end-users, including falling air-time charges, combined with the rise of prepaid calling plans;
- international standardisation and increasing compatibility of access to the various nets;
- growing Internet popularity, leading to the need to upgrade the equipment of GSM (Global Services Mobile) network providers to support Internet Protocol (IP) connectivity;
- the need for geographical expansion of existing terrestrial mobile communication networks;
- the need for technology enabling flexible and modular expansion or replacement of the existing infrastructure, according to density of mobile services usage.

Suppliers are planning to introduce:

- wireless Internet in GSM technology;
- new third-generation mobile UMTS (Universal Mobile Telecommunications System) technology, set to provide 100 times higher data rates than today's GSM and D-AMPS (Digital-Advanced Mobile Phone Service) networks;
- wireless equipment that can integrate DECT (Digital Enhanced Cordless Telecommunication) technology in the local loop, providing wireless access using point-to-multi-point technology for the backhaul and reaching the customer via wire or wireless (DECT tail).

Transmission via existing electricity grids is under testing by large energy providers that have diversified into the telecommunications area. Low-voltage grids can be used not only for tariff management, meter-reading or capacity management, but also for voice, fax, filetransfer or Internet access. The most prominent test in Europe was undertaken in the UK, while top German city utilities are also actively promoting electricity grid-based telecommunications.

In the longer term the integration of fixed and mobile networks over Internet Protocol (with the gradual shift from circuit to packet switches) is expected to play a crucial role on the overall segment developments.

Integration of fixed and mobile networks over Internet Protocol is expected to begin in the core transmission network and spread from there at different speeds beyond the access nodes to stationary and mobile terminals. Moves to replace the mobile switching centre (MSC) with a packet switch are expected to begin not earlier than three years ahead. Packet-switched mobile data service is scheduled for deployment by the end of 1999, while mobile calls are unlikely to be converted over IP until more efficient GSM or future third generation (3G) air interface protocol (than IP protocol) is available, but are likely to be converted into IP at gateways in the fixed network.

Although fixed and mobile network capabilities will converge, the fixed and mobile will still have different capabilities, with the fixed network set to remain ahead from a bandwidth and speed perspective.

As a result of IP convergence, the switching functions of mobile switching centres will be taken over by packet switches in the core network. But before this happens numerous network control functions and intelligent network features built into switches, such as mobility management, billing and equipment authorisation, must be transferred to an IP-based Intelligent Network platform. Base stations will take on a new role, serving as access nodes with intelligent gateway functions.

Solutions that enable gradual transition to fixed/mobile integration will become available and impact market dynamics after year 2000. The major benefits that would drive interest in this technology would be multimedia messaging and feature transparency, that is the ability to use fixed networks in the mobile network for such features as call-back.

Private network equipment

The private network equipment market recorded a 6.6% growth in 1998, and is expected to grow a further 6.2% in 1999.

Where more investments are really focused is in wireless Internet access equipment and mobile phones. Currently marketed cellular networks provide links to the Internet that are more than thirty times faster than today's digital wireless systems. By 2001, these wireless networks are expected to deliver voice, data and video at speeds of up to 2 megabits per second. That is on par with new digital subscriber line technology, which phone companies are using to speed Internet access over regular copper phone lines.

Mirroring this trend, the private network equipment market shows significant growth opportunities in voice over IP, wireless voice and data and DECT technology, in part due to equipment vendors' emphasis on these new offerings.

Offered as a component of multi-service networking product offerings, voice over IP (VoIP) solutions are increasingly attractive in terms of cost effectiveness. Multi-service solutions enable LAN, legacy, and integrated voice and video traffic to be sent over a single wide area network, eliminating the need for multiple networks. The new offerings can be incorporated with the organisation's existing data networks which are running a combination of LAN and legacy applications. With these new enhancements they provide users with a VoIP gateway at decreasing cost. As well as delivering voice and fax, the new offerings enable users to send video surveillance, LAN (IP) and serial data over a single network, making them ideal for organisations which are operating a multi-service Wide Area Network (WAN). These solutions are targeted to organisations running IP or mixed traffic WANs and wishing to save costs by adding voice.

The push is very strong for new business communications systems that integrate GSM wireless communications and Internet Protocol technology. The integration of GSM wireless communications into a LAN/intranet environment, gives companies their own mini GSM network. Users can move between terminals such as PC phones, multimedia terminals, or fixed IP phones, depending on their communication needs. Examples of the integrated applications enabled by this new solution include: Web-initiated telephony; directory-assisted dialling; unified messaging, and advanced conference applications sharing voice, datacom and video.

For an operator these new technologies help to increase the share of the business communications market through the ability to offer new integrated computer and telephony service packages that can easily be tailored to individual organisations and vertical market applications. Businesses and individual end-users will benefit from the local and global connectivity provided by GSM as well as from having true, one-number, one-phone service, with simple and familiar application interfaces, regardless of location. This new platform also offers a safe migration from circuit-switched to IP infrastructure, through staged addition, upgrade and replacement of equipment.

Delivering on the new vision for the fully mobile enterprise communication environment, private telecommunication equipment suppliers have added important new features in DECT technology. These include:

- the expansion of DECT handset portfolio to suit the needs of varying patterns of employee mobility;
- the linkage of DECT mobility with desk sets featuring Computer-Telephony applications, allowing users to integrate their DECT sets into their office phone sets and access a powerful range of directory services;
- the introduction of wireless desktop phones providing a completely wire-free connection to the company PBX, with significant cabling and reconfiguration cost savings.

The mobile phone sets segment is experiencing continuous high growth, too. Newly introduced cellular phones will help to enable the delivery of a new range of services such as remote ticketing, pre-paid mobile communications, and secure on-line payment mechanisms. Aiding wireless Internet access will be new software that presents Web content in a format adapted for small screens. A challenge for the industry will be to set the right price points consumers will be willing to pay for such high-speed cell phones.

Telecommunications services

Growth in the telecommunications services market reached 8.9% in 1998, and is expected to be 6.8% in 1999.

Internet telephony, multimedia applications serving the telecommunications customer, on-line information and customer-friendly service solutions are the trends that dominate the network services market.

Fixed telephone services

Preparing to defend their market position against competitive local and long-distance operators, incumbent carriers are improving operating efficiencies, reducing service prices and upgrading outdated networks. These factors, combined with the inherent advantages of nationwide coverage, brand awareness and distribution presence, will allow incumbent operators to retain their dominant position in the short to medium term.

Local and long-distance service prices are expected to continue declining as competition intensifies. These are compensated by increasing access lines (both residential and business) and traffic, driven by:

- demand for second residential lines for dial-up/Internet services;
- growth in the number of ISDN channels;
- increased traffic generated by service price reductions due to competition, as well as from Internet services;
- growth in revenues from accelerated marketing of call management services such as call waiting and call forwarding;
- expanding economic activity (affecting growth in business lines); and
- greater communications needs of businesses.

Emerging new telecommunications service providers have been active in competing with dominant carriers as value-added resellers of line capacity. They still prefer targeting business customers, most frequently within cities or regions. Competitive initiatives focus on least cost routing or on additional value-added services such as transparent billing systems, prepaid calling card services, call back services, teleconferences and support in the installation of call centres.

Service providers from the mobile area started to consider extension of their services into the voice telephony area in order to overcome one of the current advantages of the fixed-line operators: the delivery of data.

Increased voice, data and video competition is also brought by high-capacity cable networks, and electric utilities which reckon they can transmit data over power lines and deliver services via the home electric power plug. Low-voltage grids can be used for tariff management, meter-reading or capacity management. Voice, fax, filetransfer or Internet access are also possible. Satellite networks aim to extend competition to the local loop for low and medium speed digital access.

Mobile telephone services

Given its sizable base, the mobile voice market continues to show particular promise. Both growth in the number of mobile subscribers and growth in average call length contribute to boost this market. Several factors contribute to the positive trend in usage, including pre-paid service subscription offering, calling party pays, lower prices, smaller phones and longer battery life.

A third-generation mobile phone standard (UMTS) is under development in Europe and Japan, while the US is moving at a slower pace and may choose a different standard. Faster wireless data links could sway more phone users to abandon fixed-line connections, and generate more demand for multimedia mobile services in the long term.

Switched data services and wireless data

Internet-related business is the present and future opportunity for data network services. The size and variety of business growth potential is reflected by the growing number of Internet service providers that has emerged recently across Europe.

Take-up of data services on mobile networks is expected to explode with the introduction of several new technologies in the medium term:

- the Wireless Application Protocol (WAP), delivering mobile users many of the Internet features available on personal computers;
- the new General Packet Radio Service (GPRS) in GSM networks is set to increase speeds up to 100 kbit/s and run IP-based applications more smoothly to the terminal;

- the introduction of third-generation (3G) broadband wireless technologies, now being standardised by the International Telecommunication Union (ITU), promises to overcome many of today's bandwidth problems over the airwaves beginning in 2002. The European proposal is called Universal Mobile Telecommunications System (UMTS).

Cable

Driven by continuous investment by cable firms to increase household and business penetration, cable services are set to record a stable growth trend.

To drive penetration of cable services, cable companies have started their upgrade to digital TV to enable integrated provision of basic telecommunications service as well as Internet access and video telephony, through the digital TV set-top box. Also they are offering additional Internet features to make cable become a desirable vehicle from which to access the net from the home. One of the most interesting features is fully interactive TV shopping services, allowing retailers with highly developed Web sites to adapt them for TV without incurring massive costs.

To promote cable services as a cheaper alternative to leased lines for businesses and as Internet access for business and residential market, new cable modem technology is exploited by cable operators for faster data rates to real-time graphics, instant responses, high-quality video and graphics and real-time interactivity.

UK's cable TV operators are also studying the possibility of offering IP telephony services to their customers as an alternative to the conventional phone service, so to offer more advantageous rates on long-distance calls.

1.3. Europe as a consumption area

1.3.1. ICT penetration

Despite the 1998 improvement in its growth profile, the European IT market is still growing at a slower pace than the global average. Variations in IT adoption remain high across countries.

The penetration of mobile connections continued to increase faster in the most developed and economically stronger regions, but late comers started to recover faster in penetration rate levels.

The Nordic countries and the UK confirmed higher intensity in investment in ICT technology.

1.3.2. ICT adoption by industry

Banking was the most active adopter of ICT during 1998, and is expected to continue to invest heavily also in 1999. Unlike the Year 2000 issue – a technical issue – the challenges posed by the introduction of the Euro proved to be strategic, and are affecting the way banks are doing business, forcing them to rethink their information systems. The focus is on customers. Customer management system solutions call for database and datawarehousing technology. Innovative delivery channels are another major driver. ATM, and smart card technology lead the way. Internet banking and electronic signature are making inroads. The introduction of the Euro will further increase the interest in developing compatible e-purse systems that work across borders within the Euro-zone.

The *manufacturing* sector has continued its restructuring process: streamlining and cost cutting were the major aim of this trend. Companies efforts to create new organisational structures have caused reviews of their information systems. Integrated enterprises applications, and networking technology (Intranet,

Table 7
IT penetration by country, 1997

	IT/GDP %	IT per capita (ECU)	Number of business PCs per 100 white collar workers	Number of PCs per 100 population
Western Europe	2.34	460	55	18
EU	2.31	445	54	18
Germany	2.13	492	51	22
France	2.51	526	54	18
UK	3.36	627	57	22
Italy	1.45	268	46	10
Spain	1.41	168	50	8
Austria	2.08	463	62	20
Belgium/Luxembourg	2.38	495	52	15
Denmark	2.96	803	68	34
Finland	2.64	520	63	29
Greece	0.88	84	37	6
Ireland	2.05	333	84	16
Netherlands	2.92	578	64	30
Norway	2.65	778	110	36
Portugal	1.41	128	27	7
Sweden	3.45	782	85	35
Switzerland	3.19	1,012	83	34
US	4.53	1,075	105	47
Japan	2.61	745	24	13

Source: EITO, IDC, OECD

Extranet) were therefore the major drivers of IT growth for the European manufacturing industry. The millennium bug has presented a major business challenge which is extensive because, apart from information systems, the task involves correcting information technology infrastructure, factory and process control facilities and telecommunications networks for both voice and data. Processing industries showed a higher propensity to ICT spending than discrete ones.

Demand for *business services* is booming. Consulting companies are benefiting the most due to the Euro and the Year 2000 issues. However, growth could be inhibited by the skill shortage the sector is suffering.

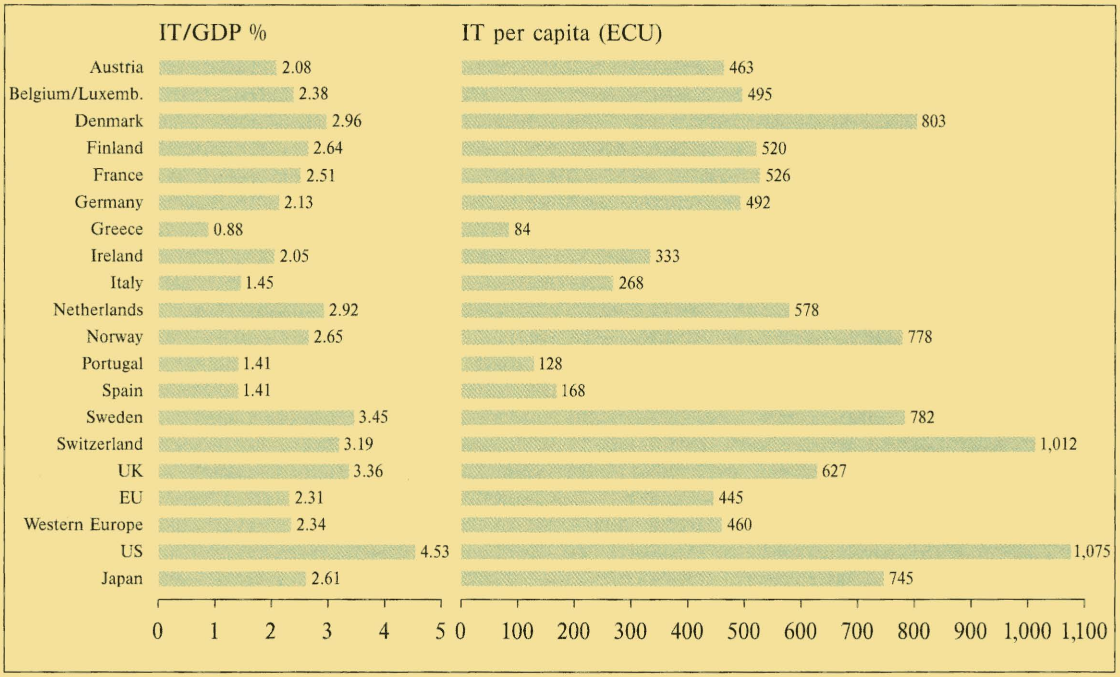


Figure 8
IT/GDP and IT per capita in Western Europe, the US and Japan, 1997

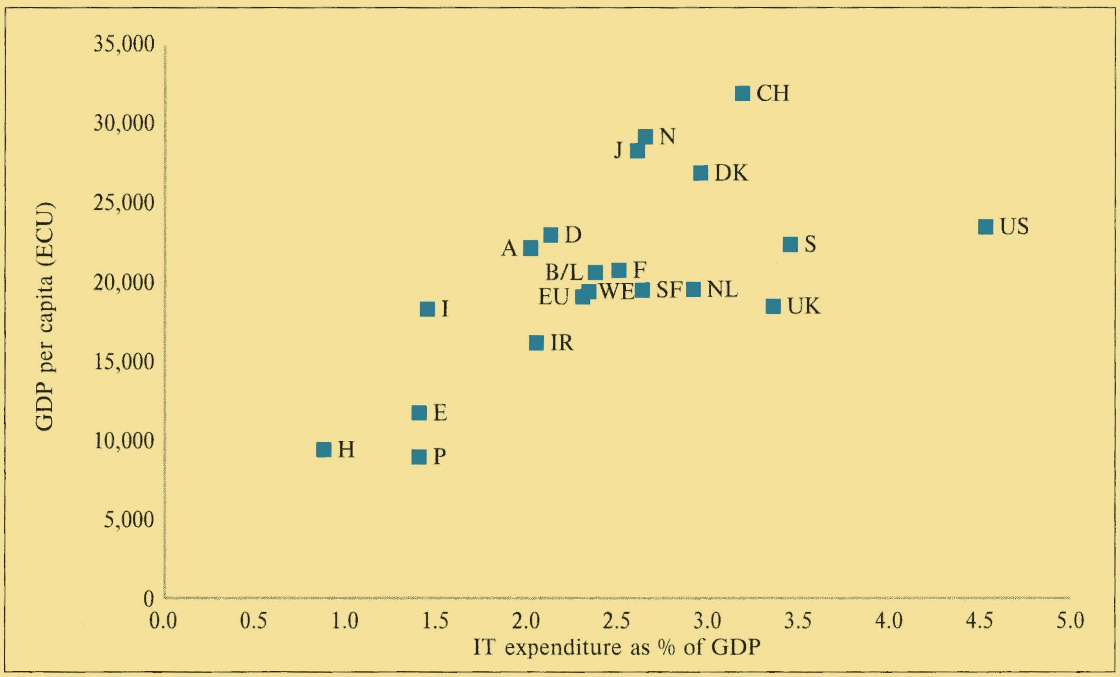


Figure 9
IT/GDP versus per capita GDP in Western Europe, 1997

Table 8
Telecommunications penetration by country, 1997

	Inhabitants (000)	Households (000)	Main lines per 100 inhabitants in %	Mobile subscribers (%)	CaTV subscribers per HH (%)	% of digital main lines
Western Europe	385,473	153,740	52.0	14.2	28.2	95.4
Germany	82,200	37,339	55.2	10.0	49.5	100.0
France	58,500	23,545	57.7	9.9	9.8	100.0
UK	58,900	24,600	53.6	14.2	9.8	97.0
Italy	57,380	20,482	44.6	20.4	0.3	93.5
Spain	39,280	12,160	40.4	11.0	13.5	80.7
Austria	8,090	3,096	49.6	14.4	34.9	79.4
Belgium/Lux.	10,603	4,265	47.6	9.9	88.7	78.9
Denmark	5,280	2,403	62.9	28.2	43.3	85.4
Finland	5,130	2,130	55.8	41.9	39.1	100.0
Greece	10,500	3,624	51.7	9.3	0.1	47.4
Ireland	3,600	1,192	40.6	14.2	49.1	87.5
Netherlands	15,700	6,489	56.5	10.8	89.2	86.8
Norway	4,400	2,035	60.9	38.3	35.8	60.9
Portugal	9,910	3,295	40.4	15.2	11.3	40.4
Sweden	8,900	4,078	68.5	35.8	47.5	99.0
Switzerland	7,100	3,007	66.2	14.7	79.5	91.4
Bulgaria	8,419	2,935	32.0	0.6	6.8	7.9
Czech Republic	10,300	4,038	31.8	5.1	21.8	50.0
Hungary	10,174	3,987	30.5	6.9	31.1	77.4
Poland	38,662	12,693	18.9	2.2	23.6	46.6
Romania	22,551	7,473	16.0	0.9	34.5	31.8

Source: EITO Task Force

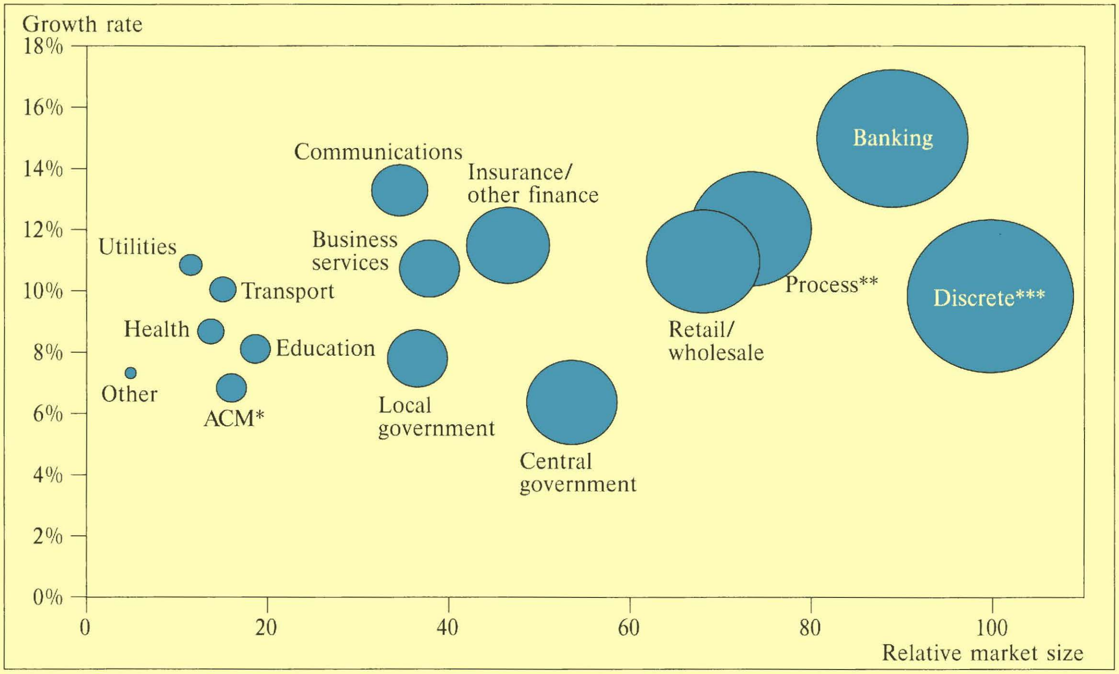


Figure 10
Western European vertical market outlook, 1998

* ACM: Agriculture, Construction, Mining
** Process manufacturing includes industries that transform raw materials into products (production and preliminary processing of metals, non-metallic mineral products, fibre, food, drink and tobacco, textile, paper and paper products, rubber and plastics) or into substances with new physical and chemical properties (chemicals).
*** Discrete manufacturing includes industries that transform semi-finished products into final products.

The *retail* industry has undergone enormous changes. Consolidation through internal growth as well as mergers and acquisitions, and globalisation are affecting the market. To compete in this new scenario, retailers are asking for technology to better configure their supply chain, to manage their store operations and to exploit new ways of interacting with customers. The optimisation/automation of the retailers supply chain and the availability of real-time information involve big potential cost savings, while data processing and storage costs give retailers the ability to track their customers on an individual basis. Another major revolution is expected with a wider acceptance and usage of the Internet for sales transactions. Major advantages for retailers include the zero inventory and real estate costs, as well as the possibility to reach customers across the world. On the other hand, customers can benefit from lower prices, quicker access to newly released products, and wider assortment.

Deregulation and privatisation are changing the competitive environment in the *utilities* sector. Another important aspect is the growing interaction between the gas, telecommunications, and electricity industries: the emergence of the so-called multi-utility. The ability to manage change in the complex multi-utility dimension will yield considerable cross-sectoral efficiencies, enabling to offer consumers innovative services and utility packages. In retail and customer-oriented businesses such as utilities detailed customer-specific information has become crucial. Demand for customer management solutions, and billing solutions, is therefore increasing. IT demand is focused on application solutions (billing, pay-roll, financial, storage management, administration system), networking technology, integrated application and desktop management, maintenance and update services.

IT software and services are playing a crucial role in helping *telecommunications* companies adapt to new demands (mobility, Internet services, customer relationship management). The need to provide access to data more quickly and effectively will continue to drive telecommunications IT demand, while the focus on customers will result in increasing demand for customer relationship management as well as billing solutions. Demand for information sharing and collaborative technology, server technology to support the organisation as well as increased usage of NCs (Network Computers) for dedicated applications characterised IT spending in the sector in 1998.

Government IT spending continued to be weak in 1998 with the exception of UK central and local government. Hardware maintenance and system support, automated budgeting systems, kiosks delivering information on job vacancies, and processing passport applications have been major areas of focus.

Customer relationship systems, customer support via the Internet and reservation system technology aimed to improve service and increase customer satisfaction and loyalty have characterised IT spending in the *transport* sector. ERP, networking technology, and datawarehousing were other major drivers.

1.4. Europe as a production area

1.4.1. Current status in employment and production

Employment in the IT industry declined from 935,000 in 1996 to 928,000 people (or 1.1% of European employees) in 1997 (however available data on employment in high growth industry are subject to the risk of underestimation). The hardware sector was the major driver of decline, mainly due to the headcount downsizing trend of major hardware vendors in Europe, M&A consolidation (especially in the PC sector), closing manufacturing sites, and shift of manufacturing activities in the distribution channel. Employment in hardware manufacturing activity passed from 205,000 people in 1996 to 190,000 in 1997.

The software, services, and distribution channel segments showed a continuous increase in employment, accounting for 738,000 employees in 1997 (730,000 in 1996). Growth in headcount in the software segment was mostly contributed by the increasing internationalisation drive of European software suppliers. IT services staff increase was linked to the increasing demand for new external IT staff, able to fulfill expertise needs in new technology areas, or as a result of staff shift as part of outsourcing contracts.

The European telecommunications industry employed 1,060,000 people in 1997, slightly up from 1,050,000 in 1996. This trend is set to continue in 1998, as staff lay-offs of the traditional telecommunications operators have been offset by new hiring of new entrants in the telecommunication markets as well as by the hundreds of ISP start-ups that have populated the Western European scene.

European user companies employ more than 8 million IT equivalent jobs (that is one full-time person, or two people spending half their time on IT, or five people each spending 20%). Western Europe's skills requirements of in-house IT departments is forecast to grow, but the available pool of staff will increase at a slower pace than demand. The skills shortage problem will be particularly serious at the small and medium business level. By about 2000, the number of vacancies in the IT departments of user companies will exceed the total number of ICT professionals employed by companies in the industry.

The most often required skills include project management, interpersonal and communication skills, the ability to prioritise, and understanding business issues associated with deep understanding of ICT. Many user firms have already been driven to outsource their IT functions because of the difficulty or expense of recruiting people with the skills they needed. This promises strong business growth to companies and employment in the IT service sector.

The shortage of skills is set to become more acute unless urgent action is taken to step up training and reskilling initiatives (more detail is available in section 3.2.).

1.4.2. R&D effort

At the end of 1998 a compromise was reached between the European Parliament, the Commission and the Council on the Fifth Framework Programme (FP5) for Research and Development for 1998-2002. A total budget of ECU 14,960 million was agreed, somewhere between the request of the European Parliament, which had proposed a larger budget, and the position of budget-conscious Member States. The budget allocated for research projects in the ICT area, covered in the "Information Society Technologies Programme" is equal to ECU 3,600 million (or 26% of the total). Some ECU 850 million of this amount should be committed in 1999.

The Information Society Technologies (IST) Programme will be a single integrated programme, unlike the Fourth Framework Programme, which comprised separate specific programmes for the ICT area, and will address the following areas (key actions):

- systems and services for the citizen (ECU 612 million);
- multimedia content and tools (ECU 612 million);
- new methods of working and electronic commerce (ECU 612 million);
- essential technologies and infrastructure (ECU 1,296 million).

Generic research activities will also be funded, as well as measures for improving the research infrastructure:

- future and emerging technologies (ECU 360 million);
- research networking (ECU 108 million).

The IST Programme will fund between 35% and 50% of the total cost of projects, with the possibility of up to 100% funding for some particular types of project. Some take-up activities will be eligible for funding and other activities known from the Fourth Framework Programme will continue, including accompanying measures, concerted actions and thematic network, fellowships, SME exploratory awards and co-operative research.

The Commission is also promoting venture capital initiatives taking risks by investing in the creation of high-technology businesses. Examples of new partnerships between the public sector and private operators supporting innovation include the "Growth and Employment" initiative, with funding of ECU 400 million (managed by the European Investment Fund), and the I-TEC pilot project. The I-TEC network has 30 venture-capital funds as of end 1998, for an additional funding of almost ECU 500 million for innovative firms.

Other major R&D private and public initiatives conducted in 1998 include:

- localisation software for computerised translation of programme interfaces within the framework of an EU research programme on software localisation;
- research centre for the development of software for the finance industry in the areas of intelligent agents, e-commerce drivers, key determinants of consumers adoption, new computational approaches to predicting financial consumer behaviour;
- exchange of intellectual property on chip and software technology to ease development of applications in data storage and PC-compatible information appliances;
- university and industrial research co-operation in the area of design and development of leading edge fibre-optic products;
- telecommunications operators joint or individual R&D efforts in the areas of IP technology.

An interesting approach is being developed by the UK government to encourage research and aid cash-flow in the companies start-up years. A series of initiatives would be replacing the current system of giving an allowance against corporation tax when the company makes a profit. These initiatives would include:

- extra incentives such as a volume-based R&D tax credit in the small to medium-size enterprises sector;
- a plan to simplify tax on intellectual property by giving tax allowance on purchases but taxing proceeds;
- a plan to allow royalty receipts to be received gross as far as possible;
- a plan to make permanent the temporary investment allowance for small business introduced in 1997.

1.4.3. Concentration, mergers, acquisitions and co-operation in the ICT industry

Concentration

The number of IT companies whose combined market share accounts for some 40% of the European IT market remained stable at nine in 1997, despite different national dynamics as outlined below (figures are for the data-processing sector only, excluding office products):

Number of leading IT companies with combined market share of 40%

	1992	1993	1994	1995	1996	1997
Austria	3	4	4	4	4	4
Belgium	7	6	7	8	8	8
Denmark	5	4	5	5	4	4
Finland	4	4	5	4	4	4
France	8	9	10	9	9	9
Germany	4	6	6	5	7	6
Greece	4	3	2	5	5	6
Ireland	4	6	6	7	5	6
Italy	2	2	3	3	5	6
Netherlands	6	5	6	7	7	7
Norway	5	7	8	7	8	8
Portugal	4	3	3	3	4	4
Spain	5	5	5	5	5	6
Sweden	9	8	6	7	7	7
Switzerland	7	7	6	6	8	9
United Kingdom	9	10	9	7	11	10
Western Europe	7	8	7	8	9	9

Mergers, acquisitions and co-operation in the ICT industry

European mergers & acquisitions activity has been characterised by a strong increase in the number of deals, and average deal value, with media and telecommunications playing a strong role in an unprecedented number of industry-shaping "mega" transactions.

Software products and IT services transactions recorded continuous strong growth, as a result of both specific catalysts, such as the requirement for skills to handle Year 2000 and Euro preparation work, as well as a general drive for both product and services companies to deliver enterprise-wide "solutions" to larger customers. The acceleration in the deal frequency in this segment suggests the increasing recourse of companies to M&A to develop economies of scale, scope and location.

The IT services market has seen a huge amount of activity with new entrants and former hardware-focused companies making aggressive use of M&A to position themselves as solutions providers. M&A in the supporting services sector was relatively flat with only some areas, such as the distribution channel for IT hardware in Germany, recording heavy activity.

The technology and media convergence between content and software providers has also accounted for strong activity in 1998, as players strive to deliver value-added information directly to the desktop. Information publishers try to enrich their content package offering by acquiring technology for the service "front end", such as technology enabling access to a wealth of very specific databases offering one-of-a-kind content.

The January 1998 deregulation date for European telecoms has led telecoms companies to reposition themselves to compete through a wave of stake-selling initiatives aimed at building transcontinental partnerships, to enter international alliances as well as the world of Internet and intranet services. This trend has gradually given way in the last part of 1998 to more strategic transactions where European PTOs have focused on building a wider array of services offerings and controlling global access to key corporate customers. As a result there has also been a sharp rise in the number of convergence transactions between the telecoms and IT services industries, including acquisition by telecom companies of network integration or IT services businesses.

In the second half of 1998, advancements in telecoms technology have started to make acquisition of content and Internet service providers attractive, as they enable telecom operators to provide a new platform on which to offer European consumers and corporations access to a digital environment for information, communications and entertainment.

Together with the above-mentioned trend, the convergence of telecoms and datacoms has been creating high demand for IP technology for both IT and telecommunications players.

To face increasing competition from other regions' suppliers telecommunication equipment suppliers in Europe have started new acquisition initiatives to own innovative technologies, especially in the Internet platform arena. Acquisition is preferred to home-grown efforts as a route to own innovative technology, because the market requires high focus and timing of innovation which are more typical of a small start-up than of large equipment companies. To ensure Europe's major equipment suppliers a strong IP product portfolio, 1998 take-overs involved in particular Gigabit Ethernet technology start-ups, remote access and internetworking technlogy, ATM access products, WAN routers, cable modems, wireless access solutions for wideband applications. Other IP offerings developed by European equipment suppliers are home-grown or come from partnerships.

Equipment suppliers are also creating venture funds to continue acquisition over the next few years in such innovative technology as IP data networking, optical wireless broadband, and network management software applications.

Almost a half of transactions in Europe were performed by North American companies, closely followed by UK companies. The relatively stable economic environment of Europe, as it prepared for the Euro, has constrained the ambitions of continental corporations as potential buyers. Despite an overall increase in IT and communications deals across Europe as a whole since 1995, companies based in Germany, France, Italy, Benelux and the Netherlands, as a group, made fewer acquisitions in the last year than they did two years ago.

Last but not least, new types of organisation structure are implemented at IT and telecom suppliers to provide for a stronger customer interface, faster and more entrepreneurial product development and supply, more transparent reporting procedures and stronger strategic direction setting.

1.5. Trade in the European Union

The European Union continues to run a trade deficit in IT and telecommunications products. The negative balance worsened in 1997. It passed from some –18 billion ECU in 1996, to –23 billion ECU in 1997. The telecommunications market continued to drive exports growth. Exports rose by some 28%, from some 77 billion ECU in 1996 to some 99 billion ECU in 1997.

Table 9
EU trade by country. Office machines and EDP equipment, 1997, million ECU

		EU	Non-EU	US	Japan	4 Tigers	RoW	Total
EU	Import	51,479	659	13,004	8,149	13,604	10,181	97,076
	Export	60,123	2,761	6,163	1,678	1,623	7,305	79,654
	Trade balance	8,644	2,103	- 6,841	- 6,470	- 11,982	- 2,876	- 17,423
Germany	Import	7,862	220	2,187	2,646	2,862	2,182	17,959
	Export	7,449	643	679	104	172	1,687	10,733
	Trade balance	- 413	423	- 1,508	- 2,543	- 2,690	- 495	- 7,226
France	Import	7,045	60	1,506	768	1,826	1,102	12,306
	Export	6,943	332	557	48	196	1,141	9,217
	Trade balance	- 101	272	- 949	- 719	- 1,630	38	- 3,089
UK	Import	8,631	82	3,681	1,452	3,458	2,512	19,816
	Export	12,871	586	2,250	868	561	1,641	18,778
	Trade balance	4,241	505	- 1,431	- 584	- 2,897	- 871	- 1,038
Italy	Import	4,696	36	513	189	470	339	6,243
	Export	2,479	72	334	59	69	366	3,380
	Trade balance	- 2,216	36	- 179	- 130	- 401	26	- 2,863
Spain	Import	2,325	14	283	101	178	269	3,170
	Export	697	11	229	4	85	91	1,116
	Trade balance	- 1,628	- 3	- 54	- 97	- 93	- 178	- 2,053

Note: Non-EU includes Iceland, Norway, Liechtenstein, the Faroe Islands and Switzerland.

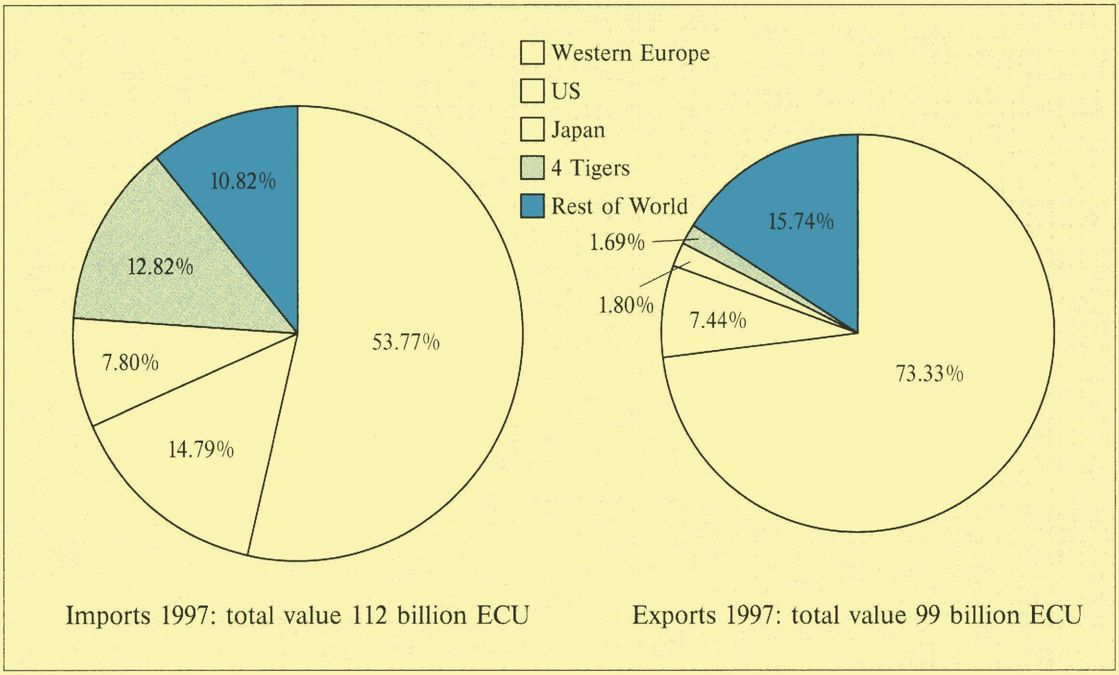


Figure 11
EU total ICT equipment imports/exports by region, 1997

Table 10
EU trade by country. Telecommunications equipment, 1997, million ECU

		EU	Non-EU	US	Japan	4 Tigers	RoW	Total
EU	Import	7,649	419	3,554	590	744	1,932	14,887
	Export	8,803	700	1,183	98	50	8,229	19,063
	Trade balance	1,154	281	- 2,371	- 492	- 694	6,298	4,176
Germany	Import	840	148	537	163	167	367	2,221
	Export	954	182	186	19	180	2,157	3,679
	Trade balance	114	34	- 350	- 144	14	1,791	1,458
France	Import	748	23	337	81	25	241	1,456
	Export	929	64	56	5	85	726	1,865
	Trade balance	181	41	- 282	- 76	59	486	409
UK	Import	1,681	73	1,441	131	195	662	4,184
	Export	2,315	112	452	21	262	1,004	4,166
	Trade balance	634	39	- 989	- 110	66	342	- 18
Italy	Import	879	8	157	35	73	126	1,277
	Export	890	16	15	0	25	523	1,469
	Trade balance	11	8	- 141	- 34	- 48	397	192
Spain	Import	748	14	97	12	19	65	956
	Export	234	3	21	1	3	417	679
	Trade balance	- 514	- 11	- 76	- 12	- 16	352	- 277

Note: Non-EU includes Iceland, Norway, Liechtenstein, the Faroe Islands and Switzerland.

2. The impact of the Internet

2.1. Internet usage

Significant investments have been made in the European Internet infrastructure and in the development of Internet connectivity and value-added services. Most of the efforts are still geared towards solving security, capacity, and privacy issues in Europe, with a longer-term vision of turning the Internet into a multimedia platform supporting voice, video, image, broadcast entertainment and commercial transactions.

Major trends include:

- the number of devices accessing the Web in Western Europe will grow from 14.2 million by the end of 1997 to almost 58 million by the end of 2001;
- the number of Internet/online active accounts[1] will grow from 27 million at yearend 1997 to 68 million at yearend 2001;
- the number of Internet devices and active accounts in Western Europe will cross over between 1998-2001 as a result of an increasing deployment of multiple access points to the Web from new device types such as portable PCs, NetTVs, and smart hand-held devices. An increasing overlap between business and home usage also plays a role;
- Germany and the UK are the largest Internet market in Western Europe, each with an Internet population of over 5 million Internet/online-active accounts by yearend 1997;
- although some of the slower Internet adopting countries in Europe - Spain, and Italy - are expected to pick up speed, these countries are forecast to have year 2001 Internet populations only on a level with or even below those of much smaller North European countries, such as the Netherlands and Sweden;
- 5.9% of all inhabitants in Western Europe (including Turkey) now have Internet-active accounts with penetration rates by country varying from 1% (Greece) to 13.8% (Sweden). Nordic countries take the clear lead but also Switzerland, the UK, and Germany are above the Western European average;
- the percentage of active accounts buying goods and services on the Web will grow modestly, reaching 34% for home active accounts and 20% for business ones by yearend 2001. Internet commerce revenues in Western Europe between 1998 and 2001 will grow exponentially. Business-to-business Internet commerce is expected to take the lead, as businesses switch from paper-, fax-, or EDI-based purchasing to Web-based purchasing.

[1] Internet/online-active accounts: The number of active accounts includes residential users, who access the Internet via their own account, and business users, who have their own e-mail-address. Users with both business and residential account are counted as two active accounts. Not included in the number of active accounts are second- or third-users of one account, and accounts, which are not used on a regular basis (Web-access at least once a month) or only for e-mail.

Table 11
Estimated Internet/ online active accounts (thousands) in Western Europe, 1995-2001

	1995	1996	1997	1998	1999	2000	2001
Business users	6,466	10,679	13,898	14,269	14,676	15,660	16,547
Home users	5,860	10,027	12,641	19,637	28,507	39,063	51,224
Total[1]	**12,326**	**20,706**	**26,539**	**33,906**	**43,183**	**54,723**	**67,771**

[1] Incl. Turkey

Drivers of Internet adoption include the following:

- The drive amongst businesses to implement effective communication and collaboration mechanisms is paving the way for Internet adoption. As of end 1998, 89% of business PCs had a LAN connection. The next step for these organisations is connectivity across a wider area, facilitated by Internet or intranet technology.
- PTOs (public telecommunications operators) initiatives are raising interest in the Internet (e.g. Deutsche Telekom subsidiary T-Mobil, with several German media companies and US company Infoseek Corp, has set up joint venture that will offer a German-language Internet search and navigation service from spring 1999, under the name Infoseek. France Télécom plans to expand Minitel, its successful but antiquated online service, into a state-of-the-art Internet system. Minitel already provides a wide range of national information and commercial services, including the ability to order goods and services electronically).

Some inhibitors that could slow the deployment of Internet technologies and reduce the Internet services market opportunity include the following:

- Telecommunication tariffs remain relatively high throughout Europe in the consumer market and can dissuade consumers from adopting Internet technologies.
- In Southern Europe and France, PC penetration has been lower than in the rest of Europe. As long as the PC is the main access device to the Internet, Internet adoption patterns, and ultimately the demand for Internet services, will be slow.

Table 12
Internet hostcount and Internet hosts per 1,000 population

	Internet hostcount			Internet hosts per 1,000 pop.	
	Year-end 1997*	Year-end 1998**	% growth	Year-end 1997*	Year-end 1998**
Austria	108,473	172,569	59	13.4	21.3
Belgium	106,808	208,665	95	10.1	19.7
Denmark	169,368	298,275	76	32.4	56.5
Finland	486,811	459,568	– 6	94.9	89.6
France	355,031	511,193	44	6.1	8.7
Germany	1,132,174	1,449,915	28	13.8	17.6
Greece	28,131	49,904	77	2.7	4.8
Ireland	39,864	55,859	40	11.1	15.5
Italy	254,296	386,632	52	4.4	6.7
Netherlands	391,228	625,769	60	25.1	39.9
Norway	292,382	318,993	9	66.6	72.5
Portugal	42,447	55,746	31	4.3	5.6
Spain	196,403	306,559	56	5.0	7.8
Sweden	348,609	379,455	9	39.3	42.6
Switzerland	189,175	245,409	30	26.8	34.6
UK	1,017,452	1,449,315	42	17.3	24.6
Western Europe	5,158,652	6,973,826	35	13.4	18.1

* 30 Dec. 97, ** 5 Jan. 1999 — Source: RIPE

While the total installed base of PCs increases significantly during the period 1998-2001, reaching almost 120 million devices in 2001, the number of PCs without Internet access will be stable. By 2001 there will still be more than 50 million devices in Western Europe that are not accessing the Internet, and there will remain a relatively large installed base of older PCs that cannot fully exploit the applications on the Internet – especially in homes. Many European homes will acquire Internet access by purchasing a set-top box connected to their TV.

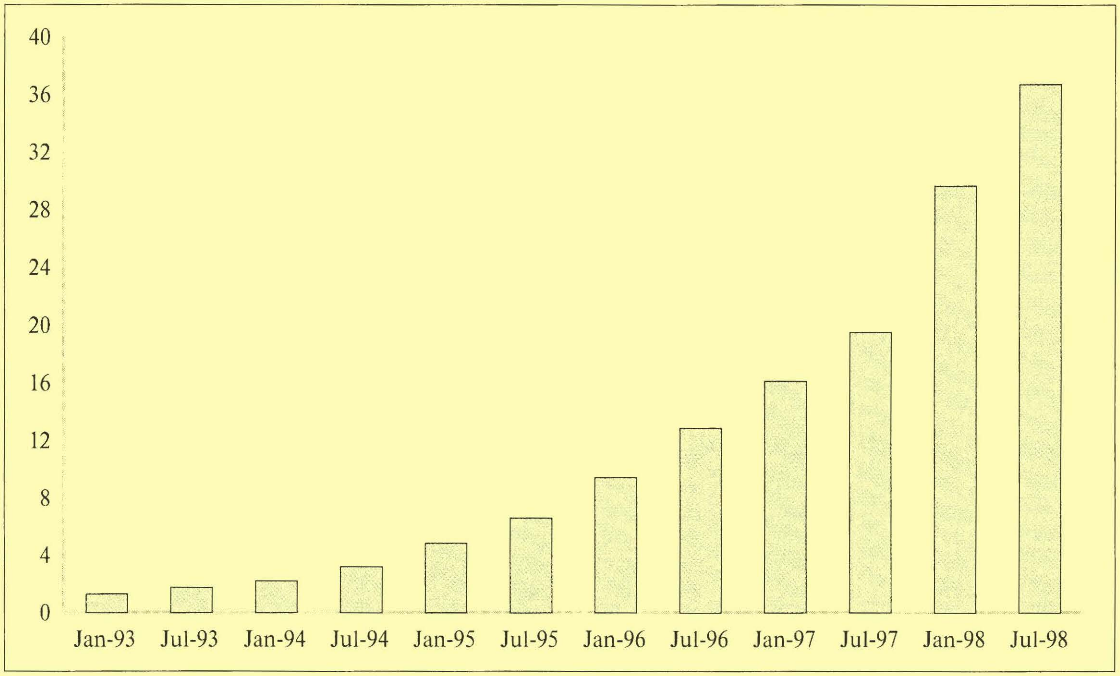


Figure 12 Worldwide number of Internet hosts, millions, 1993-1998

Source: Network Wizards [www.nw.com]

2.1.1. User segments

Home users

One of the biggest challenges to be faced before the Internet becomes a mass market in Europe is how to enable households without PCs to have Internet access. Even when low-cost devices (less than ECU 180) become widely available, the need to purchase the device will still be a barrier to adoption, unless packaged with a range of attractive services and content which is not available elsewhere.

The launch of a wide range of information appliances (devices aimed at simplifying and reducing the costs of accessing the Web) will encourage households to use the Internet. During 1999 the market will see an explosion of new products introduced in the form of TV set-top boxes, Web-enabled TVs, Web-enabled screen-phones, Web-enabled video-game consoles, Web-enabled personal digital assistants (PDAs), and more.

Currently, 35% of the Western Europeans who use the Internet from work or school also use it from home. This overlap is significantly lower than in the US due to the lower PC and Internet penetration in Europe.

The overlap between European home and business home users is expected to increase steadily, reaching 55% in 2001. This is due to more and more European homes getting connected. Many of the Europeans who invest in an Internet connection will do so because they have become accustomed to using the

Internet at work. A reasonable portion of the coming European home Internet users will additionally be sponsored by their employers, who want their employees to spend time at home learning the technology. Also students will increasingly find it affordable to use the Internet from home where, unlike at school, there are no limitations on when the computers can be used.

The high European telecommunications charges are an additional reason for Europeans not to use the Internet from home, when they can use it from work for free. However, liberalisation of voice in Europe will help to drive the Internet consumer market in particular by lowering access costs.

Toward 2001, the home segment is expected to take over the business segment as Western Europe's leading Internet access point.

Businesses

Western Europe is now finally reaching the critical mass of Web usage, that in the US triggered the booming popularity of intranets much earlier. There is now a sufficient base of common Web tools, infrastructure, and user skills needed to bring the benefits of both Internet and intranet applications into the European enterprise.

European companies have started later than their US counterparts, but a less bumpy road ahead for intranets in Europe is predicted. Not only is Internet technology becoming more pervasive in Europe. New Internet standards in areas such as calendaring/scheduling, messaging, security, and directories will furthermore enable intranet solutions to deliver functionality comparable or superior to that of proprietary systems. Business users are proving the benefits from the increasing use of the Internet for intra- and inter-applications. Messaging applications such as Internet fax are natural extensions from e-mail, but Web-hosted applications such as Internet commerce will take longer to evolve.

More than 74% of large sites in Europe have access to the Internet, while a respectable 50% of small ones (10-99 employees) can access the Internet. Among large sites (+500 employees), education and banking have the largest number of sites with Internet access, followed by insurance/other finance and professional services. Major interest to Internet access is demonstrated by small sites in the education and professional services sector.

2.2. Regulatory framework

As the need for electronic commerce and communications harmonisation increases, differing initiatives have been developed to address the problem.

The EU is addressing several issues: taxation of products and services; tariffs; protection of international property rights; encryption; authentication; data protection; liability. The approach is to favour industry-led initiatives, where appropriate, rather than impose regulations. Regulation should be kept to a minimum to try to create workable procedures. However, real actions resulting from this are not likely to come into force until mid- to end-1999.

Moves are under way to enhance trust and confidence for Internet commerce in Europe. Many companies and organisations are planning to offer some form of certification service, but there is a need for a standardised pan-European infrastructure and processes to support the process.

Several European initiatives are in progress to address these issues. An important one is a move by the European Electronic Messaging Association (EEMA) to create a European Certification Authority Forum (ECAF). Before the use of digital certificates, private and public keys and digital signatures becomes widespread, many critical issues have to be resolved including inter-working, codes of conduct, cross-certification and legal issues. ECAF could be the coordinating body to help craft processes and procedures to deal with all these essential elements.

There is a handful of CA (Certification Authority) services available in Europe. A number of different types of organisations have expressed an interest in developing CA services, either directly or in partnerships. Emerging players in this market include: PTOs, postal authorities, managed network service companies, financial companies, others, such as large consulting firms and software companies.

Another important issue is digital signature. Digital signatures allow someone receiving data received over electronic networks to determine the origin of the data (identity) and to verify whether the data has been altered or not (integrity). The data is accompanied by a certificate, issued by a certification service provider, which allows the recipient of a message to check the identity of the sender. This way, digital signatures should give to an electronic document the same role as a signed paper document.

A proposal for a Directive establishing a legal framework for the use of digital signatures has been put forward by the European Commission. By laying down minimum rules concerning security and liability, the proposal would ensure digital signatures were legally recognised throughout the European Union. This would create a framework for secure on-line transactions throughout the Single Market and so stimulate investment in electronic commerce services with ensuing benefits for the EU in terms of growth, competitiveness and employment.

Industry is expected to take the lead with standardisation bodies in developing internationally agreed standards for electronic signatures. These standards should focus on establishing an open environment for inter-operable products and services. The role of the Commission will be to support this process.

The different initiatives in the Member States may lead to a divergent legal situation. Although Member States seem to focus on the same issues (in particular the requirements on service providers and products, the condition under which electronic signatures will have legal effect, and the structure of accreditation schemes), it becomes apparent that the relevant regulations, or the lack of them, will be different to the extent that the functioning of the Internal Market in the field of electronic signatures is going to be endangered. Divergent rules concerning the legal effect attributed to electronic signature are particularly detrimental to the further development of electronic commerce. The objective pursued by the Proposal for a European Parliament and Council Directive on a common framework for electronic signatures is to remove obstacles, in particular differences concerning the legal recognition of electronic signatures and restrictions on the free movement of certification services and products between the Member States.

Fourth Report on the Status of Implementation of the EC Telecommunications Regulatory Package

The Commission's assessment of effective compliance is as follows:

- ***National regulatory authorities***

Regulatory authorities have begun operations in all Member States, and are co-operating and exchanging information on a systematic basis with each other and with the Commission. While it is reasonable to expect that they will require time to become fully effective, all have begun to implement the principles laid down in the regulatory package.

There are, however, some concerns as to the sufficiency of the powers and resources available to them, the degree of separation from the body controlling the incumbent, and clarity of the division of powers between the different bodies to which NRA tasks have been devolved.

- ***Licensing***

The national frameworks in place appear to be functioning well, with large numbers of new players authorised to enter the market; the procedures applied in practice conform broadly to the requirements of the package.

Concerns relate in particular to onerous licence conditions, lack of transparency in regard to conditions and procedures, the level of fees and the length of time required in certain cases to issue licences.

- ***Interconnection***

A significant number of interconnection agreements are already in place in the Community. There is evidence that interconnection charges are beginning to converge on best practice charges, thereby contributing to the level of service competition.

There are concerns as to the excessive length of negotiations, the scarcity of agreements in the fixed market, the inadequacy of reference interconnection offers and the lack of transparency relating to cost accounting systems.

- ***Universal service***

Schemes for financing universal service have been set up in only a limited number of Member States.

There is concern relating to the calculation of the amount of the contribution from market players.

- ***Tariffs/accounting systems***

Tariff rebalancing has not been completed in a number of Member States.

The fact that tariffs are not sufficiently cost oriented produces anti-competitive effects in certain market segments and increases the cost burden on other sectors of the economy.

- ***Numbering***

Operators do not appear to be squeezed due to lack of availability of numbers. Carrier selection is operating at least partially in most Member States, while number portability has been introduced ahead of schedule in some of them.

The incumbents in a small minority of Member States appear to exercise an undue influence on the allocation of numbers.

- ***Frequency***

All Member States have issued at least two GSM and one DCS 1800 licence.

Concerns relate to the period required in some Member States for the phasing out of analogue systems.

- ***Rights of way***

Network operators are granted the right to use public ways in virtually all Member States.

Practical problems appear to exist in several Member States with regard to the use of public ways and sea cables, and in a small number with regard to private land.

In summary, there appear to be no areas in which significant failures have occurred in the practical application of nationally transposed legislation, although corrective action is required on a number of points in a number of countries.

2.3. Impact on the ICT market

2.3.1. Impact on hardware

Internet servers

The increasing use of Web servers, as platforms for distributing and sharing information over the Internet and intranets, has created an additional demand for server hardware.

The Western European hardware server market derived from the implementation of Internet servers is expected to grow from 36,000 units in 1996 to 247,000 units in 2001. Hardware server shipments may be the result of shipments of both commercial and free Internet server software, and the forecast adjusts for the fact that multiple software servers may be installed on the same hardware server, and that shipments of new software servers may in some cases be implemented on existing ("old") hardware servers within the end-user organisation.

In this early stage of Internet development in Europe, expanding the local base of Internet users and setting up simple hosted external Web sites is the primary concern. This has brought special attention to the hardware investments of European ISPs (Internet Service Providers). The ISP community has appeared as the single largest Internet server hardware sales opportunity. ISPs are strongly investing in hardware to support their soaring numbers of Internet access subscribers - consumers as well as businesses. The ISP market is particularly important to the revenues of Unix-based Internet servers in Western Europe, while the large majority of non-Unix-based Internet hardware servers are shipped to corporate end-users. Although the Internet market focus will shift from expanding the Internet user base to developing corporate infrastructures based on Internet technology, ISPs will remain an important segment.

Client segment

Driven by the fast development of Internet-oriented computing in Western Europe, and the search for simpler and less costly personal systems, a market is beginning to emerge for what is broadly defined as the "thin client". The devices on offer are extremely diverse - not least in terms of price - and there is an option of many products now for (pioneering) customers to select from. The thin client market is showing classic features of an emerging IT market, with a lack of standard form factors and wide-scale experimentation, as suppliers grope towards practical solutions. The two main classes of TCs (Thin Client) are the enterprise Network Computer (NC) and the Windows-based terminal (WBT). These desktop technologies are classified as "thin" due to the fact that both focus more on application access than application processing. Hence, they tend to have a smaller operating system in contrast to a PC. Currently Network Computers and Windows-based terminals are mainly being bought as terminal replacements in Western Europe, though some PC replacement has been taking place, and home Internet appliances are likely to become a threat to the consumer PC early in the next decade.

The growth of the Internet is also driving the development of a dizzying array of new information appliance devices, including TV set-top boxes, Web-enabled telephones, Web-enabled personal digital assistants (PDAs), and Web-enabled videogame consoles.

2.3.2. Impact on software

Internet tools

The impact of the Internet on the computer industry is felt on several software markets. Knowledge management, and the move to Web-centric systems are major drivers for Internet applications. Application development tools is probably the software market to feel the greatest influence of Internet adoption. This will first impact the forefront countries while the medium to late adopters will trail behind in a few years time frame. Countries with a strong tradition for in-house application development, however, also constitute an attractive market for Internet tools.

The market potential for Internet tools (Web professional development tools, which provide Web site and Web page design, object integration, and management capabilities for Web site and page development) can be attributed to several drivers:

- overall adoption of Web sites, whether as external home pages or corporate intranets;
- the extent to which the services offered on Web sites are dynamic, i.e. are applications rather than static information;
- the extent to which users develop applications internally rather than purchase standard packaged Web solutions.

The demand for Internet tools is also driven by the type of services and content hosted on Web sites and intranets.

At this moment, most European Web sites and intranets are used for hosting "electronic paper" types of content - i.e. static HTML pages, which do not require high-end tools to develop. Today's typical Web content include product sheets, company background information, employee notices, etc. On the corporate intranets, the applications used typically do not replace any of the company's existing mission-critical applications. More mission-critical applications such as commerce applications, transaction processing, collaborative applications will be hosted in European Web environments over the next couple of years. This will create an increased demand for more advanced Internet development tools in Europe.

Web server software

The European Web server software market is an increasingly Wintel-dominated market at the lower end of the market. The Wintel domination is a natural result of the increasing popularity of NT and Intel as a *de facto* server standard.

Although the corporate market is an important segment, it is not the only market for Web server software. The ISP segment is becoming increasingly important, and their purchasing patterns differ significantly from corporate buyers in their inclination toward buying higher-end Risc/Unix systems rather than Wintel systems.

Browsers

The next generation of client software for accessing the Web consists of browser suites that go beyond mere browsing; they incorporate functions such as netcasting, mail, news, and Web page creation, as well as providing an interface to Java applications. Browser suites will be standard for both new and existing users who upgrade to the next browser release.

Firewalls

Firewalls have been the answer to questions about Internet security. The firewall market has therefore grown tremendously. Looking forward, however, users realise that they need other tools and procedures in addition to firewalls. Consequently, the direction for Internet security is toward global solutions that incorporate encryption, authentication, digital certificates, public key management, and standards support.

2.3.3. Impact on telecommunications

Internet Service Providers

There are an estimated 3,000 ISPs (Internet Service Providers) in Western Europe. The number is still rising overall, but this overall growth hides considerable consolidation in the Nordic region.

Significant structural changes in the ISP industry are taking place through acquisition, mergers or new financing requirements. Many ISPs are raising further funding and a number have been acquired or undergone a merger. Consolidation is taking place in virtually every European country, and the rate is set to accellerate. Emerging non-traditional ISPs, such as banks, charging very low or no access fees to consumers are putting further downward pressure on dial margins in the consumer sector. A number of strategic and tactical factors will continue to drive alliance and merger activity in Europe among the PTOs (Public Telecom Operators) and ISPs. These include:

- to extend geographic reach;
- to increase market penetration and maintain existing clients;
- to focus on business markets rather than mass markets in order to be able to offer a variety of price entry points and profit margins;
- to provide the basis for aggressive price differentiation through a range of services and geographic locations;
- to increase buying power to reduce network access costs;
- bundling of services;
- a wider range of distribution channels;
- to capitalise on existing infrastructure and implement new technology platforms in support of more services such as voice, video and audio streaming.

Although ISPs have the edge over PTOs in their Internet knowledge and know-how, few European ISPs have the resources to meet the PTOs head-on, and this will ultimately be the biggest threat. PTOs are in a position to dominate the Internet market as they hold the two most important cards – infrastructure and financial resources. PTOs increasing revenues from additional Internet call traffic demonstrate this trend.

However, in liberalised markets, the incumbent PTO is not guaranteed a leading position and still has to convince prospective customers that it has the same level of Web expertise as the independent ISPs. The obvious advantage of the PTO and facilities-based ISPs is that they are in a much stronger position to support guaranteed service levels, which will be of equal importance to companies migrating to Internet services for LAN interconnect, extranets and VPNs (Virtual Private Networks).

Many ISPs are investing strongly to face this situation. ISPs spend between 130% and 300% of their annual sales. ISPs are investing for future capacity and growth (typically one to two years). Most ISPs are in the process of adding capacity in anticipation of future subscribers, volumes and new services. ISPs are investing heavily to upgrade access speeds, expand backbone trunk capacity, and improve quality of service (guaranteed latency) features to support mission-critical VPNs, remote access and extranets for business customers.

Facilities-based ISPs will have clear advantages in terms of costs and ability to offer more service level guarantees. This trend will accelerate the moves of some ISPs away from connection-oriented services to value-added services, increasing the demand for managed IP capacity, albeit from a smaller number of players.

One of the marketing challenges faced by ISPs at this stage of the market's development is how to convince businesses of the benefits of investing in higher value-added applications such as Internet commerce and IP-based VPNs.

Internet value-added services have not yet become a particularly important part of the offerings of the ISPs and PTOs in revenue terms. ISPs generate the vast majority of their sales from the provision of Internet access and connectivity: in Europe approximately 80% of revenues are from access services.

Value-added services offered by ISPs include Web site hosting services, groupware/messaging/chat services, Internet fax/telephony, and electronic commerce. The most important value-added service areas are Web site hosting, collaboration (specifically groupware), Internet commerce, and Internet fax/telephony. The primary area of new solutions development by ISPs is in business communications services including intranets and extranets that complement or replace corporate network infrastructures.

Increasing equipment features enable network operators to approach the access market with multiple technologies and to differentiate their offering by developing services off the Central Office Switch.

Many equipment companies are starting to introduce products that offer new intelligent call-handling features. Intelligent call-handling technology can help carriers and service providers more economically roll out value-added services, such as premium levels of access, voice and fax over IP and virtual private networking (VPN).

Intelligent call handling will be needed during the next two to five years as voice and data networks come together. It is a classic next-generation public switched telephone network service.

Intelligent Network (IN) software solutions let online Internet users receive a call-waiting message on their computer screens when a telephone call comes in on the same phone line used for surfing.

The user has the option of routing the call to voice mail, ignoring the call or accepting the call. This last option terminates the user's session and connects the incoming call to the user's phone.

A further step would be to extend intelligent call-handling capabilities to data calls. For incumbent carriers who have a huge investment in central office switching equipment, intelligent call handling can relieve congestion in central office switches. The Internet is causing congestion problems, with one-way calling patterns, long hold times and call routing limited by in-band signalling. While the most common situation is that in a central office carriers don't control a call's destiny, new call-handling technology offers better call control because it uses out-of-band signalling, and makes sure a telephone is available before completing a call.

An incumbent carrier can also use call-handling capabilities to more economically roll out new services. Today many carriers and service providers use a shared set of dial-access ports for their basic services such as a monthly flat-rate Internet service. And carriers typically dedicate specific ports for premium services like a guaranteed call-completion service that ensures the user will not get a busy signal.

In the next few years, it will be common for carriers to offer tiered levels of service where a user can select a higher Quality-of-Service level, for example, at a premium price. In the same time period, carriers are looking to support increasing numbers of users of value-added services such as voice over IP or VPN.

With today's approach to handling incoming calls, carriers and service providers will have to dedicate large numbers of dial ports to these premium services.

While most internetworking and central office switch technology providers pursue strategies that link the IP and public switched worlds, many are also focusing on adding intelligence to their remote access concentrators.

The trend is to use any port for any service, dynamically allocating each port on a call-by-call basis. This reduces the cost of equipment for a carrier or service provider since they would no longer have to dedicate specific ports to premium services. The ability to dynamically allocate ports can lead to some interesting offerings from service providers. For example, a carrier or ISP could tie just-in-time provisioning to a marketing campaign where an ISP increases its number of ports dedicated to a dial-access number as soon as an ad appears - and then have the ability to cut back after the promotional campaign ends.

Whichever way they attack the market, ISPs are increasingly having to think in terms of partnering with the telecommunication operators in order to survive in the corporate market. Alliance and share participation by telecommunication carriers are seen as a chance to increase the proportion of ISP's corporate and leased line sales.

Remote access and bandwidth

Several technologies are competing for the ECU 9 billion that will be spent on remote access infrastructure worldwide over the next four years.

Analogue modems will remain the standard for Internet connectivity through 2000. Analogue modems continue to reign in popularity because of their easy access (almost any phone line), ease of use (widely supported by software), and low cost.

One of the hot topics for discussion is the availability or lack of availability of sufficient bandwidth for remote users to use powerful applications successfully in corporate networks and via the Internet. What everyone agrees on is that the current state of analogue modem access is insufficient to support higher-bandwidth applications, such as downloading large graphics files, images, voice, and other multimedia applications.

ISDN provides two digital links at 64 Kbps and was once hailed as the definitive upgrade for analogue modems. In Europe (especially Germany), ISDN has enjoyed much greater success also thanks to the support of the local PTO. Attractive tariffing (compared with analogue lines), widespread availability of ISDN services, and easier installation have promoted ISDN for remote access in Europe.

Two new high-bandwidth technologies, xDSL and cable modems, have entered the trial and early adoption stages. Both technologies promise significantly higher (640 Kbps to 8 Mbps) bandwidth to remote users. The ability to offer high-speed Internet or corporate access is an attractive option to cable companies with their stable base of paid subscribers. Digital subscriber lines (DSLs) are a technology designed to use existing copper phone line connections to run high-speed digital remote access services. A number of DSL technologies exist, including HDSL, SDSL, and ADSL. All of these technologies represent different methods to provide higher bandwidth over copper lines. The most prominent DSL technology, ADSL, offers asymmetric bandwidth with 640 Kbps upstream and up to 8 Mbps downstream.

DSL technology represents an exciting option for remote access because of the high penetration of basic phone lines and its ability to provide a great amount of support for existing wiring structures. Together with high-speed Internet access, uses for ADSL will include teleworking, video-on-demand, home shopping and home banking.

The surge in demand for Internet applications both among large corporates and in the small and medium business sector has increased the demand for high bandwidth and high-capacity network connections. It has also resulted in carrier-class product offerings for the remote access server market. Internet phone and fax solutions have also come onto the market.

Integrated voice/data/application platforms for branch offices and small businesses will be increasingly marketed as part of a managed network service offering by telecommunication carriers in 1999. These platforms combine PBX functions, voice mail with automated attendant, computer-telephony applications, multiprotocol routing, local-area network hub, remote access server and multiservice wide-area network modules. The remote access server market hit the ECU 500 million level in 1998.

To add high-value and additional IP products and services on the existing platforms of Europe's 20 public broadband networks based on ATM, a new range of switch routers and IP telephony gateways has been launched. Other products currently in development include ATM switching tools and end products such as edge routers and access multiplexers, new remote access servers, as well as a gateway server that turns the switch into an IP telephony system.

It is a natural progression for telecommunication carriers to move into the market for Internet services. Good control over network infrastructure provides reliability and flexibility on IP services, and that is where the telecommunication carriers want to move in. To ensure reliability, throughput and ease of use in their Internet service offerings, telecom carriers are keen on new platforms for remote access. Progressive increases in capacity will be met through a fully scalable remote access, server and backbone design. Furthermore, built-in resilience ensures guaranteed levels of service for everyone. Flexibility also characterises Internet service provision by carriers. For example variable authentication plans are offered permitting use by schools, subscription trials, pre-purchased, premium rate, time-based or unlimited access services.

Together with leased line services, they are moving towards a range of packaged services, such as dial-up services specifically aimed at corporates who want a Virtual Private Network linking remote workers to the internal network. This enables them to manage a number of dial-up accounts, with facilities to add and remove users, and change passwords and e-mail addresses online.

2.4. Internet applications

E-mail is the top inter-corporate Internet application currently in use. It is the primary driver for Internet connectivity for many businesses. Two other applications that were prevalent in this first phase of Internet use are the Web site as an advertising method and customer service. Many organisations targeted Internet use for customer service. These applications reflect something more significant in the development of the Internet than just a new communications alternative (e-mail). They reflect that the focus for a number of new initiatives revolves around corporate Web presence. Much of the motivation for the move toward using the Internet as a customer support alternative is that customers could support themselves via a Web page, thus potentially lowering corporate customer support costs. In a second phase, companies will begin to see the Internet as a source of and support mechanism for commerce.

Internet applications also play a vital role in the development of knowledge management initiatives, as interpersonal and networking skills become increasingly important. Recent developments in Internet technology have changed knowledge gathering, storing and sharing into "Web-centric" knowledge management, allowing individuals across multiple departments and organisations to access and exploit the information they hold.

E-commerce

Whilst there is tremendous growth in E-commerce applications, buying products and services over the Web is still not very common among European Web users.

Internet commerce on a grand scale requires tremendous changes in both industry's ways of doing business, in consumer behaviour, and in technology infrastructure. The concept of Internet commerce is only now starting to take a shape in Europe, and the product offering on the European part of the World Wide Web is very sparse. Except for books, music, software, information, and a few niche products there is not much to find on the shelves of the few European Internet stores in operation. Those stores that do exist in Europe today, usually offer only a small part of their product range over the Internet as a pilot test of this new sales channel. A much wider offering is available from sites in the US, where many Europeans do Internet shopping. Nonetheless, the additional time and costs of courier or air transport of products ordered is often not worth the hassle (except for digital products or very specialised products which can be found nowhere else). Furthermore, things are complicated by the perceived insecurity of online credit card payments, and the complexity of offline payments.

Consumer confidence in Internet security is expected to steadily improve over the years, as online payment systems become safer and as end-user payment becomes simpler. The biggest driver of the increase in the share of European WWW users who are buyers, however, will be the increasing number and quality of the goods and services which will be available for sale on the Internet - including the online emergence of well established local brands in each of the European countries.

The run rate of business Internet buyers will soar toward 2001. The size of business-related transactions can get much bigger than home-based transactions because business can switch from paper-, fax-, or EDI-based purchasing to Web-based purchasing. Initially, the most popular online business-to-business purchases are IT equipment and software, but other digital services such as online information, as well as standardised products such as many office supplies are likely to soon be common Internet shopping items as well.

Internet telephony

1998 has finally seen the launch of commercial Internet telephony services in Europe, by a number of ambitious next generation telecommunications and Internet Telephony Service Providers. In turn some of the incumbent PTOs are responding with plans to launch services of their own.

The level of interest is unsurprising given the potential of the technology both to allow new players to enter the market for basic telephony and also to enable new value-added applications utilising the convergence of telephony with the Internet. The clearest signs of the adoption of Internet telephony in Europe have been the announcements by Deutsche Telekom, Swisscom, Telenor and Telia of the launch of IP telephony services before the end of 1998. Other PTOs have been noticeably reticent about discussing their plans but it is clear that many of them are seriously investigating the merits of introducing services, whether to defend their market share from the new entrants or else to take advantage of the potential for new applications available through IP telephony.

However, in the short term the market will remain very small in comparison with the huge existing market for public telephony services. One of the most significant inhibiting factors to the introduction of Internet telephony services has been the issue of voice quality. Security is another major concern when considering the use of Internet telephony. The perceived lack of security on the Internet is clearly transferred to the idea of using this technology for calling purposes.

There are however a number of driving factors for voice over IP, many of which will become increasingly apparent especially in the business market. At the moment the most important driver for Internet telephony is cost. Services already introduced in Europe are offering calls to certain international destinations at well below 50% of standard PTO tariffs and also significantly below reseller prices. This is sufficient to be attractive to certain segments of the residential market despite the lower voice quality. Currently a significant factor in the low cost is the ability of Internet telephony to bypass international accounting rates.

Voice over IP is becoming of increasing interest to businesses as they adopt IP protocol for both local and wide-area networks. Together with new voice and video-over-IP products and the introduction of the H.323 standard, this opens up the possibility of the convergence of voice and data communications within the corporate environment. Further, this is also being carried into the public telecommunications services arena by progressive PTOs such as Telenor and Telecom Finland. In the context of Internet telephony specifically, this opens up the possibility of new value-added applications including: unified messaging; voice-enabled Web sites combined with call-centre applications; real-time voice, video and data sharing applications.

2.5. Convergence of ICT and media

Traditionally, media, communications, and IT were separate. Services were quite distinct – broadcasting, voice telephony and online computer services. They operated on different networks and used different "platforms": TV sets, telephones and computers. Each was regulated by different laws and different regulators, usually at national level. Nowadays digital technology allows a substantially higher capacity of traditional and new services to be transported over the same networks and to use integrated consumer devices for purposes such as telephony, television or personal computing.

Telecommunications, media and IT companies are using the flexibility of digital technologies to offer services outside their traditional business sectors, increasingly on an international or global scale.

Current activity in the market suggests that operators from the sectors affected by convergence are acting on the opportunities provided by technological advances to enhance their traditional services and to branch out into new activities. Telecommunications, media and information technology sectors are seeking cross-product and cross-platform development as well as cross-sector share-holding. Examples of new products and services being delivered include:

- home-banking and home-shopping over the Internet;
- e-mail, data and World Wide Web access over mobile phone networks, and the use of wireless links to homes and businesses to connect them to the fixed telecommunications networks;
- online services combined with television via systems such as Web-TV, as well as delivery via digital satellites and cable modems;
- e-mail and World Wide Web access via digital TV decoders and mobile telephones;
- using the Internet for voice telephony.

This trend is confirmed also by the increased interest in the information appliance market. A considerable growth is expected for this sector due to low-entry price compared with PC (especially when devices are integrated into existing technologies such as cable set-tops), the ease of use and installation compared with PC, the additional low-cost e-mail and Web browsing terminal for the PC-owning household, and the development of very low-cost interactive enabling hardware and software solutions for televisions.

Convergence is not just about technology. Convergence is a debate about the impact of technology and a quantum leap towards a mature Information Society.

The global nature of communications platforms today, in particular, the Internet, are providing a key which will open the door to the further integration of the world economy. The phenomenon of convergence is relatively new and a range of different views exist on what its implications are for society and for economic activity. There is broad agreement that developments in digital electronics and software are creating the technological potential for a new approach to the delivery and consumption of information services. There is less agreement on how much these developments will change existing practices and over what time-scales.

As convergence enables incumbent players in the telecommunications broadcasting sectors to expand their roles, it also marks the entry of powerful new players from publishing and IT industries. For information providers, such as publishers, database operators and financial information services, the Internet constitutes a crucial extension of their traditional know-how, and an ideal means of recycling and "re-purposing" rich stores of information.

Similarly, IT companies are exercising significant influence on shaping the new services market in Europe (as they move towards generalised online distribution of software and multimedia content, make substantial investments into cable and television business, and act as integrators of advanced television trials in Europe.

Barriers exist - actual or potential - which may hold back the trend towards convergence: access to users, regulatory restrictions on use of infrastructure, prices for telecommunications services, availability of content, fragmentation of EU market, insufficient IPR protection, regulatory uncertainty, multiple regulatory bodies, market entry and licensing, access to networks, conditional access systems and content, allocation of radio frequency and other resources, and public confidence in the new environment.

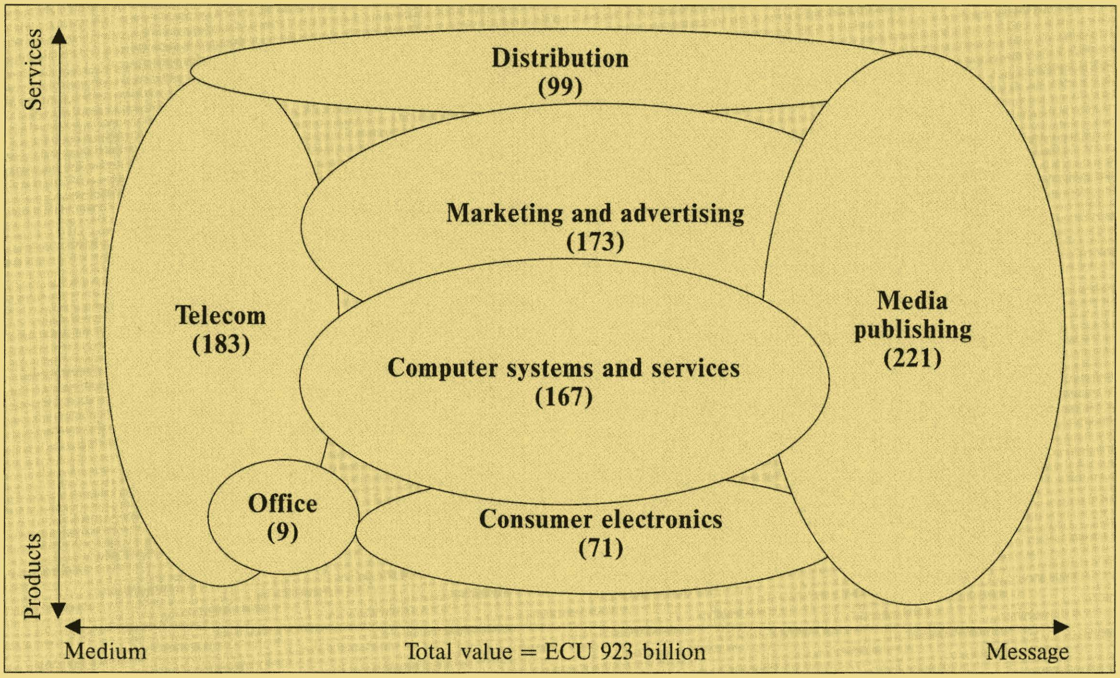


Figure 13
Western European information business arena, 1997, billion ECU

Office:
typewriters, calculators, copiers, other office equipment;

Consumer electronics:
TV sets, VCRs, radios, tapedecks, watches, etc.;

Media and publishing:
films, TV programmes, videos, CDs, records and tapes;

Computer systems and services:
hardware, packaged software, services;

Marketing and advertising:
online databases, online shopping, mail order catalogues, advertising, direct marketing, other business services;

Distribution:
broadcasting, telex/mailgram, mail, parcel, courier;

Telecommunications:
voice network services, data network services, customer premise equipment, service providing equipment, installation and maintenance.

3. Drivers and inhibitors of ICT growth

The following paragraphs focus on major inhibitors and drivers of ICT market growth.

Inhibitors include:

- infrastructures;
- skill shortage.

Drivers include:

- the Euro;
- Year 2000;
- virtualisation of the business value chain.

3.1. Infrastructures

European businesses need to face key challenges to benefit fully from the inevitable spread of Internet applications and services usage. Overall these challenges are referred to as lack or inadequacy of infrastructure. Among the chief concerns are:

- lower telecommunication infrastructure penetration rates than in the US (with the exception of very few countries);
- fragmented cultural profiles, with a wide gap in E-business use and understanding between Europe and the US;
- higher telecommunications and IT costs and competitive pressures;
- lack of technology standards and interfaces;
- weak support for E-business strategies at large companies board level;
- variety of languages and cultural differences;
- spectre of stricter EU regulation and taxation of Internet commerce;
- complexity and fragmentation of the European market;
- need for higher bandwidth to ensure quality improvement for Internet telephony and enhanced multimedia capabilities;
- slow development of standards for secure electronic transactions.

There is a growing confidence in the business environment that the issue of telecommunications costs and infrastructure inadequacies can be resolved within the next two years. More difficult to overcome are subtle cultural barriers, especially in business attitudes (in the US and Europe) toward E-commerce. These will require a longer term E-commerce usage learning process.

3.2. Skill shortage

Demand for IT skills is far outstripping the existing supply of IT professionals. As companies struggle to find the critically needed programmers, developers, and project managers, the end result is an IT skill shortage that is affecting the growth and expansion of the global IT market. As the supply for a skilled workforce becomes increasingly restricted, corporate attitudes are changing toward the valuation and regard for human capital. Although the market is not there yet, it is moving toward the realisation that effectively building and leveraging human capital development has created significant growth opportunities for IT training companies.

The IT skills shortage is a global problem that came to the fore in mid-1997 and has been receiving increased media and industry attention ever since. Trying to find the proper IT skills to fulfill internal personnel requirements has become one of the most significant challenges being faced by firms on a global scale, across the full spectrum of vertical industries. As a result, there is an increasing need in corporations to effectively recruit, maintain, leverage, and retain human capital within an organisation.

While the IT skills shortage has been evolving as a market problem for the last three years in many markets, up until late 1997, to early 1998, little has been done to develop a genuine solution. Only now, as the demand for programmers, systems analysts, and computer engineers outstrips the market supply, both customer firms and IT suppliers are realising the formidable task of competing in a human resource constrained market. As firms are faced with the challenge of being unable to do business because they cannot find the necessary skill sets, companies are realising that effective market competitors are not those firms that take away business, but those that can out-compete for required people.

The requirement for skills in Western Europe among in-house IT departments is forecast to grow from 8.3 million in 1997 to 12.2 million in 2002. The external service provider sector is forecast to increase its employment from 812,000 IT professionals in 1997 to just over 1.2 million in 2002. Based on these forecasts, the shortage of IT skills in Western Europe is set to have reached 510,000 "equivalent" IT jobs (of which 200,000 are full-time IT jobs) in 1998, and could reach 1.6 million equivalent jobs, or 12% of total demand by 2002.

While the shortage of necessary IT expertise could potentially restrict the growth of the overall IT market (particularly in the IT services market space), the situation does create significant revenue opportunity in the market. As skills receive increased attention, a growing number of customers are looking to their IT training and IT services providers, for strategies and technologies to recruit, train, maintain, retain and leverage a highly skilled workforce. Firms in the IT training industry are well positioned to benefit substantially from the current market situation. However, the possibilities for revenue generation expand well beyond the schedule classroom setting or basic CD-ROM training product that has, until recently, defined the IT training market. In many cases, customers are looking to their IT training suppliers to take a leadership role and expand beyond their traditional scope and provide methodologies, technologies and processes that will manage and leverage knowledge capital within an organisation.

In response to the growing appreciation of and interest in managing the pool of "minds" and "skill" resources within organisations, an expanding number of services firms are realising the market transformation occurring and are already moving to position themselves as their clients' primary "knowledge" partner.

3.3. Euro

With the introduction of the Euro on 1st January 1999, the Euro has replaced national currencies in Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. Other countries could join the Euro currency in the next years if their economies accomplish the convergence requirements and they decide to join. Candidates may be the UK, Denmark and Sweden that have decided not to join with the first wave.

This event had unprecedent effects on information systems. During the transition phase (the period between January 1, 1999 and January 1, 2002) both the Euro and the national currency are used within the same Member State. That implies that enterprises may be required to receive and process financial information in both Euro and national currency; they are also obliged to produce financial information either in Euro or the national currency unit or both. When enterprises switch over to Euro, the historical financial information still filed and processed in national currency units, has to be converted to Euro units.

The Euro is changing the European business environment in several aspects, leading enterprises to revise their strategies. That is leading to radical changes in the functionality and benefits expected from information systems. This kept the demand for IT services strong in 1998 and is expected to continue to drive IT services also in 1999. For IT suppliers the Euro is an opportunity and a threat at the same time: IT professionals with the skills needed for tracking Euro issues are expected to meet high demand in the 1998 to 2001 period, mostly due to scarcity of many skills type involved. But at the end of this period there will surely be an excess on offer, which may threaten the investment return of suppliers who have entered the Euro conversion consulting and service arena late.

As far as information system strategy is concerned, reaching Euro compliance generates the need for technical interventions, functional interventions, or both. Technical interventions aim to enable the information system to manage the duality between Euro and national currencies during the transition phase. Functional interventions on the other hand aim to enable new/different features expected to be operated by information systems, as a result of the adoption of the Euro by enterprises or the implementation of new European monetary rules. The status of the Euro preparation of European enterprises shows that the demand related to Euro issues has not yet reached its peak. Potential demand is heterogeneous, giving different opportunities to IT suppliers by industry and by product and service. Demand will show different patterns between local companies, multinationals and large groups, whose business environment will be differently affected by the Euro. In general terms, Euro potential demand will involve the following products/services: business and organisation consulting, IT products and services to get information systems compliant to Euro issues (end-user hardware, hardware processing power for testing, application software packages, tools, interfaces, assessment services, test methodologies, etc.), IT consulting to support the IS change and to ensure the quality of this process. The Euro will impact every application which processes financial information in one of the participating currencies. Examples of applications that are affected by the Euro include accounting software (general ledger), asset management systems, sale transactions applications.

Overall, the Euro-related IT market (external spending only) was estimated to be about 21 billion ECU in 1998 (10.88% of total IT market) and 23 billion ECU in 1999 (10.86% of total IT market). The most Euro-affected vertical markets segments are expected to end their changeover to the Euro by 1999. Those verticals include banking, other finance and government. The others are more likely to use all the transition phase to fulfill Euro compliance.

3.4. Year 2000

Achieving Year 2000 compliance is indeed a daunting task. The Year 2000 problem has the following characteristics: it is a very large maintenance task, requiring a review of all or most applications; it has immovable deadlines for completion.

There are a number of approaches to correcting the Year 2000 problem, including the following: to re-host and/or rewrite applications in modern languages on new platforms (this approach may be part of a larger business process reengineering initiative); to replace legacy, noncompliant, custom applications with commercially available packaged solutions; to renovate legacy code to achieve Year 2000 compliance. These approaches are not mutually exclusive, and many companies are indeed employing a combination of approaches using both internal and external resources. Clearly, the overriding consideration for any business addressing the

Year 2000 problem is to do whatever is necessary to ensure that it can function effectively through and after the dawn of the new millennium.

Large companies, particularly those in highly date-sensitive industries like banking and insurance, are making steady progress towards compliance; many smaller companies still have not seriously addressed the problem, and too many companies of all sizes lack adequate testing processes. Time is clearly of the essence, and companies that don't immediately address Year 2000 issues are in serious danger of failing to complete projects on time.

The first step in any Year 2000 renovation effort is to understand exactly what applications exist; it is also important to know which are still used and by whom. Compiling an updated portfolio of applications has many benefits beyond 2000. It lays the foundation for future efforts in reengineering, application migration or modernisation, and other mass change tasks (e.g., EMU, area codes, part numbers). The majority of Year 2000 efforts are being conducted primarily in-house, regardless of the strategy selected (renovation or replacement) The use of tools to address various aspects of the Year 2000 problem is deemed most important for code modification, assessment and testing.

Software tool vendors are playing a major role in Year 2000 compliance efforts. They are employing a wide range of strategies that include offering renovation services, extending existing tools to include Year 2000-specific features, and partnering with service providers. Overall, there have been winners and losers. For instance, enterprise services packaged application vendors have grown dramatically, but it is not possible to attribute this growth solely to Year 2000. Services firms have fared well, even if they are experiencing reductions in demand for older, traditional services such as system integration and business process reengineering. The reason behind this reduction is that companies faced with a Year 2000 problem have undertaken its solution at minimum cost and have not increased their IT operating budgets enough to allow their IT organisations to continue spending at the same level as before on non-Year 2000 projects. Instead, these companies have shifted priorities and managed to reduce spending or defer projects in other areas.

The challenge to tackle the millennium bug is proving much more difficult than expected (and these problems are common to all European countries), because: budgets are escalating fast; many large companies are falling behind schedule and struggling with unexpected supply chains and embedded software problems; testing compliance presents massive difficulties; preparation for the Euro, rapidly reducing time and too few skilled people are making the task harder; the public sector is behind more than the private sector.

3.5. Virtualisation of the information and business value chain

Lowering costs, improving efficiency and productivity, shortening lead times, and providing better customer services make it increasingly necessary for companies to redesign their business from suppliers to customers to integrate their supply chain. Supply Chain Reengineering is the natural evolution of BPR (Business Process Reengineering) to automate and optimise inter-company processes. The integration of interactions between customers and internal processes through the redesign of single operations can be pursued through Supply Chain Automation (SCA).

Within most companies today, there is little automated integration among internal operational systems, market intelligence systems, and supply chain planning and optimisation systems. Although these independent systems are important, far greater benefit will be realised when these systems are fully integrated as an automated closed-loop business solution. To automate the supply chain means to create a network able to define, execute and control business process and activities across departmental, geographic, and enterprise boundaries. Major drivers for the automation of the supply chain include: closer collaboration, improving efficiency, improving the flow of information along the chain, increasing visibility, lowering costs, and control over the whole business.

SCA will be a major driver of the application sector in the next five years. Application solution providers will act as a drag on the overall IT market.

The automation of the supply chain calls, moreover, for integrated enterprise applications, data warehouses, technology for planning and for optimisation, collaboration tools (Internet, workflow, groupware), general tools (middleware, Java).

The technological evolution of ICT and standards

This paper has been provided by M. Bozzetti on behalf of SMAU in close co-operation with the EITO Task Force.

1. Evolutions in ICT: a global view

The aim of this paper is to provide an overview of the most significant technological factors affecting Information and Communication Technology (ICT), which are of decisive importance for the market now and in the near future. For the ICT future trends, other factors of significant influence need to be considered, such as social, legislative, and business process changes, but this analysis is outside the scope of the present report. The technological factors are necessary but not sufficient indicators of possibilities rather than the determinants of change.

As in previous EITO reports, we shall consider basic ICT technologies to be microelectronics, hardware platforms, software and telecommunications.

These technologies co-operate and interoperate by means of architectures, and their evolution plays a significant role in ICT, which both influences and is influenced by the developments taking place in the technologies themselves.

The paper concentrates on the technological trends affecting the "industrial" state of the art, and not the most advanced laboratory R&D results; but even in this context, the reports cannot be exhaustive because of reasons of space and the fact that some of the information has already been presented in previous editions. This report will concentrate more on specific aspects concerning "technological differentials".

The Internet remains the main driving force for innovation in the whole of the ICT field, and has had a great impact on the megatrends considered over the last few years:

- the continuing miniaturisation of electronic components, which has led to a parallel reduction in production costs (and therefore price), greater reliability and improved ease of use;
- the continuous evolution of ICT products and systems towards becoming ubiquitous and powerful tools for both business and domestic use;
- the continuous improvement of human/machine interactions, with the goal of reaching a natural quality interface;
- the continuous migration from analogue to digital, from fixed to mobile, and from voice/text to multimedia equipment, regardless of distance or physical location of the equipment itself;
- the accelerating convergence of ICT and media, particularly in the case of Web/TV services and the emergence of a set of new multimedia products that will have a considerable impact on consumer electronics and the media market; in the case of traditional ICT environments, convergence with the consumer market is reshaping the present scenario and current standards.

The major factors involved are:

- the Internet Protocol (IP) is becoming the "standard" for the whole ICT area and driving the evolution of both public and private networks;

- applications are becoming Web-enabling, and browsers are increasingly becoming the only (standard) interfaces for both interactive and hyper-multimedia environments;
- ICT security is becoming an increasingly important element in ICT architectures;
- the new component- and object-based development systems, which are capable of managing interactive-hypermultimedia, are emerging and are going to integrate previously separate applications and middleware environments.

All technologies are contributing towards the evolution of ICT, but the "hottest" include very and ultra large system integration (ULSI), wireless and fibre optic systems, very high speed communication systems, storage technologies, speech processing (in particular continuous speech processing recognition), image processing, display technologies, and battery technologies. Software technology is probably neither so engineered nor so advanced as hardware technology, but its evolution is continuous.

As described in previous reports, standardisation is continuing to play a key role, and the merging of computers, telecommunications, consumer electronics and multimedia techniques requires the constant introduction of new standards. In addition to the traditional international *de jure* bodies, such as the ISO and ITU, the major reference point is now the Internet Engineering Task Force (IETF). An important role is also being played by the large number of fora and consortia such as the World Wide Web Consortium [http://www.w3.org] that provide *de facto* standards for the products for which they were set up, and these are becoming increasingly accepted as having *de jure* status. The distinction between *de jure* and *de facto* standards is becoming less significant for users but, in any case, not even these standards should be seen as static influences or constraints on the introduction of innovations.

The Internet Engineering Task Force [http://www.ietf.cnri.reston.va.us/] is the Internet protocol engineering and development group, and provides both Internet-Drafts and Requests for Comments (RFC). RFCs are official document series that are permanently archived: although not all RFCs are standards, the majority have become the reference standards for Internet and are freely available on-line as public domain documents, something that has greatly facilitated their widespread diffusion.

The International Organisation for Standardisation (ISO) [http://www.iso.ch], the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU) [http://www.itu.ch], together with its CCITT and CCIR Consultative Committees, are the worldwide *de jure* standardisation bodies operating in the interdisciplinary ICT sector. Their European counterparts are the European standards organisations: the Comité Européen de Normalisation (CEN), the Comité Européen de Normalisation Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI) [http://www.etsi.fr].

The Standards Board of the Institute of Electrical and Electronics Engineers (IEEE) [http://stdsbbs.ieee.org] is the engine for the standardisation of LANs with its 802 set of recommendations that are also included in the ISO IS 8802 series.

Whenever possible, the appropriate Web reference of all of the organisations mentioned below will be given in order to make it easier for the reader to find more updated and detailed information.

2. Microelectronics

The microelectronic evolution is continuing to lead to smaller devices with greater elaboration capacities mainly as a result of new architectures, improved design and manufacture, and the use of new interconnection methods - all of which are strictly interrelated.

As pointed out by Bell Labs Technology Trends & Development [http://www.lucent.com/ideas2/perspectives/trends], the last five decades have seen the average capacity of a silicon IC (Integrated Circuit) chip increase by about 60% per year and its computational power by about 25%. Over the same period, the cost of ICs per function has gone down by about 30% per year. With reference to the dominant IC technology of complementary metal oxide semiconductors (CMOS), a single chip can integrate up to 300 million transistors.

In order to understand this key technological trend better, the same source considers the value added to silicon during the process from sand (the first basic raw material) into a packaged circuit. One kilogram of sand currently costs about US$ 0.04 (four cents); after being refined in order to yield polysilicon, the same sand is worth about US$ 80; and after the silicon crystals drawn from the molten polysilicon have been sawed into wafers, this value increases up to US$ 3,200.

Following a similar value chain for ICs, a kilogram of processed wafers is worth up to US$ 70,000, a kilogram of IC chips is worth US$ 1,000,000 and a kilogram of packaged ICs is worth about US$ 6,000,000. From the beginning to the end, the added value is about 150 million percent.

The manufacturing of silicon chips is approaching the limit more for economic than for technological/physical reasons. The speed and performance of a chip are dictated by lithographic technology, which determines the minimum printable size, its throughput and its cost. A lithographic system includes an exposure tool, mask and resist, as well as all of the processing steps needed to accomplish pattern transfer from mask to resist and finally devices.

The current leading edge lithographic tools are optical, but future steps could be based on different technologies, including X-ray, electron-beam, extreme ultraviolet, and ion projection lithographies.

The most advanced foundries currently make 0.25-micron circuits using deep-ultraviolet steppers with a wavelength of 245 nanometers (nm). The next generation will probably have a wavelength of 193 nm, which will allow a thickness of 0.13-0.18 microns. The current cost of setting up an advanced foundry for 12-inch wafers is about US$ 2 billion.

Assuming that this trend remains constant over the next few years, it is technologically feasible that the minimum size of CMOS circuits can be reduced from the present 250 nm to 50 nm by using 250 gigabit memory chips and 10 GHz clock circuits.

As mentioned in previous EITO reports, this “integration” generates not only financial (investment/risk) problems, but also physical problems. The increasingly complex metal structures of silicon circuits create problems in controlling current flows and researchers are now looking for new solutions, such as new copper conductors, more leak-proof insulators, dielectric materials that avoid the tunnelling effect due to quantum mechanics, and even the future (if any) atomic-scale control of IC material.

The roadmap of the Semiconductor Industries Association [http://www.semichips.org] periodically forecasts the progress of the IC industry and underlines the fact that the semiconductor life cycles are changing from three to approximately two years.

In the case of Application Specific ICs (ASICs), Digital Signal Processing (DSP) and microcontrollers, the trend described in EITO 98 has been confirmed: they are being increasingly used in the areas of TLC and multimedia image/sound management, and the main innovations include new packages, greater integration, improved efficiency and more switching/reconfiguration capabilities.

2.1. New technologies

2.1.1. Copper interconnect technology

The industry has a pressing need to find a replacement for the long-used aluminium wiring and silicon-dioxide insulation. It is beginning to look as if low-resistance copper links with new materials for low-k insulators are strong candidates in this area.

As shown in *Table 1,* the major manufacturers have already introduced IC production processes for copper wiring in order to lower connection resistance (by about 40-45%), improve performance, density and reliability, and avoid the main limitations of aluminium, which include a high level of resistance, vulnerability to electromigration and stress-induced voids in the alloy.

The present technology allows six layers of copper metallisation.

The move from aluminium wiring and standard silicon-dioxide insulators is being driven by the need to shrink interconnect structures, increase speed, decrease power consumption and heat generation, and eliminate electromigration problems. One of the biggest problems is that copper is a particularly difficult material to introduce in the manufacturing of silicon circuits because it may cause active devices to fail if the metal is not well controlled with barriers.

2.1.2. Silicon-On-Insulator (SOI)

IBM's new SOI process protects the millions of tiny transistors on a chip with a "blanket" of insulation, thus reducing the harmful electrical effects that sap energy and hinder performance.

SOI chips can improve performance by up to 35%: e.g. a microprocessor designed to operate at 400 MHz can be built to achieve speeds of more than 500 MHz.

Furthermore, even if performance levels are held constant, SOI chips can require as little as one-third of the power needed by today's microchips. This is an important development because reducing the power necessary to operate chip circuitry can significantly extend the battery life of portable devices, such as cell phones, mobile computers, and personal digital assistants (PDAs).

Table 1
Planned use of copper technology

Microprocessor	Technology	Target for copper
IBM PowerPC	.20 micron	now
Motorola PowerPC	.15 micron	now
Motorola 4Mbit SRAM	.20 micron	now
Digital Alpha	.18 micron	in production by mid-1999
Sun Sparc	.18 micron	in production in 2000
AMD K7	.18 micron	introducing in 2000
Intel Merced	.13 micron	in production in 2001

2.2. Microprocessors

The use of 64-bit microprocessors as CPUs for professional workstations and all top-class PC systems is spreading (Alpha, PowerPC, x860, Merced).

Explicitly Parallel Instruction Computing (EPIC) is the announced next generation technology, and represents a kind of generic philosophy or collection of RISC or CISC techniques. It is worth noting that the difference between CISC (Complex Instruction Set Computing) and RISC (Reduced Instruction Set Computing) systems is becoming increasingly small as both architectures are trying to steal the best features of the other. CISC systems use a complex of instructions that often require different internal clock cycles, whereas RISC systems use a reduced set of simple instructions so that each instruction can be executed in one cycle (or less).

The common technological trends include five metal layers, speculative processing (branch prediction), a large number of registers and a separate cache memory bus. In terms of high-cost planning and manufacturing, the usual approach is to go for modular planning in order to reduce production cycles.

Table 2 summarises the key characteristics of the top-level CPUs of the major manufacturers. As described in EITO 98, SPECint95 and

Table 2
Technical characteristics of the main advanced CPUs

Producer	Model	Target clock speed	SPEC Int 95	SPEC FP 95	Technology
AMD/NexGen [www.amd.com]	K6-2 K6-3 K7	400 MHz 500 MHz >500 MHz	n.a.	n.a.	CMOS/0.25-micron CMOS/0.25-micron CMOS/0.22-micron
Cyrix [www.cyrix.com]	MXi MediaGX M3	300 MHz 266 MHz 800 MHz	n.a.	n.a.	CMOS/0.25-micron, CMOS/0.25-micron CMOS/0.18-micron
DEC [www.digital.com]	Alpha 21264	>800 MHz	n.a.	n.a.	CMOS/0.35-micron, 64 bit, 4 instructions per clock cycle
DEC	Alpha 21364	>1000 MHz	70	120	n.a.
HP [www.hp.com]	PA-8500	440 MHz	~ 32	~ 52	CMOS/0.25-micron, 64 bit
IBM	PowerPC RS64-II Power3 PowerPC G3	262 MHz 200 MHz 400 MHz	n.a. 13.2 17.6	n.a. 30.1 12.2	CMOS/0.20-micron
Intel	Pentium II (Xeon)	500 MHz	>17.4	>13	CMOS/0.25-micron
Intel-HP	Merced (P7)	600+ MHz	>40	>75	64 bit, announced, architecture IA64
MIPS/SGI [www.mips.com]	R10000	275 MHz	>12	>24	CMOC/0.35-micron, 64 bit
Motorola	PowerPC G3 PowerPC G4	366 MHz 500 MHz	16.1 n.a.	9.9 n.a.	CMOS/0.18-micron
Sun [www.sun.com]	Ultra Sparc-II Ultra Sparc-III	360 MHz 600 MHz	16.1 >35	23.5 >60	CMOS/0.35-micron CMOS/0.18-micron

n.a.: not available

SPECfp95 (published by Standard Performance Evaluation Corporation [SPEC] [http://www.spec.org]) have become standard benchmarks for measuring and controlling CPU performances. CPU95 evaluates CPU memories and the generation of compiled code performances.

The CFP95 part of CPU95 benchmarks the most "CPU intensive" aspect of numerical and scientific applications. SPECfp95 tests are used to estimate processing speed, which is expressed as the ratio between the time spent to make a copy of the benchmark to the time expected by SPEC parameters.

2.2.1. IA64 – Explicitly Parallel Instruction Computing (EPIC)

IA-64 architecture, a joint effort between Intel and HP, is an instruction set for a new kind of processor technology called Explicitly Parallel Instruction Computing (EPIC). The Intel Merced chip will be the first processor to implement the IA-64 instruction set.

EPIC is intended to enhance instruction level parallelism by having the compiler explicitly tell the processor which instructions can be executed in parallel, and which depend on what others.

A great deal of transistor real-estate is currently devoted to determining data dependency among various instructions, reordering them and issuing parallel execution units. Intel calls this "implicit parallelism" because the sequential machine code "implies" what code can be executed in parallel.

With this new kind of architecture, the determination of parallelism relies exclusively on the compiler, which then explicitly informs the processor. The compiler can take its own sweet time to find out what can and cannot be done in parallel, and then emit the appropriate code. The code is obviously sequentially ordered in the memory, but the instructions include codes that tell the processor about the parallelism.

IA-64 compilers will use a technique called "predication" to remove the penalties caused by mispredicted branches and the need to jump over blocks of code beyond branches. When a CPU encounters a predicated branch at run time, it will begin executing the code along all of the destinations of the branch, exploiting as much parallelism as possible; when it discovers the actual branch outcome, it stores the valid results and discards the others.

Speculation is another means of hiding memory latency. Memory has not been keeping pace with processors, and we have now come to the point at which it is necessary to wait for extra clock cycles even if the data is in a cache somewhere. Compilers try to move the load as far as possible from where the data is used so that they can carry out some other instructions in parallel in the mean time. However, it can only be sent so far and this is usually not far enough; the use of speculative loads will allow the compiler to move them further up and thus better hide that latency.

Compilers will be crucial to the success of IA-64, because (if they are to be used at all) predication and speculation by definition require a compiler in order to transform the code.

2.2.2. System-on-a-chip

Another innovation is system-on-a-chip (SOC) technology, which is considered to be particularly useful in the design of consumer devices and mobile systems. The aim is to integrate custom hardware development with memories, processors, special-purpose cores, operating systems, firmware and application software in such a way as to create a unified system-on-a-chip design and verification capability.

In this world, hardware/software co-design represents a critical and crucial component of any successful design environment. However, it may be that the real methodological advance is not the attempt to create seamless bridges between these disparate areas of hardware and software in order to form a single environment, but that of re-evaluating the relationship between an application and its implementation.

Design and verification is becoming a question of mapping an application onto a target platform. This trend already exists in the embedded software market of microprocessor-based platforms, such as Personal Java (PJava) and Windows CE (see also 5.1.). Rather than inventing a new implementation platform for every system, designers will be able to take advantage of the predefined platforms available on the market.

2.2.3. Cooling technologies

The heat resulting from the crowding of an ever-increasing number of transistors into the same space leads to greater unreliability. The first approach to chip cooling is to reduce the voltage at which the chip runs, but the constant doubling of the number of transitions still leaves heat dissipation as one of the gating factors limiting CPU speed. A promising innovation has been introduced by KryoTech [http://www.kryotech.com] with its low-cost "vapour-phase refrigeration" process – the same refrigeration technology that cools refrigerators and homes.

In a vapour phase refrigeration system, cooling is accomplished by means of the expansion of a refrigerant from a liquid into a gas state at the heat accumulation side of the cooling cycle ("the evaporator"). The expanded gas returns to the compressor, where it is then compressed to a near-liquid state. At the heat rejection or "condenser" side, the heat is subsequently ejected into the environment and the refrigerant gas changes back to a liquid. From here, it returns to the evaporator, and the closed-loop cycle is repeated.

By cooling the chips to -40 degrees Celsius, the electrons and holes within a semiconductor can move around more freely (30-35% more quickly), and this has a direct impact on chip speed.

2.3. Memories

Dual in-line memory module (DIMM) SDRAMs are replacing SIMM EDO-RAMs on mainboards. As an alternative to SDRAM, Intel is supporting RDRAM (Rambus DRAM), which has a speed of up to 600 MHz, whereas a consortium of computer vendors is working on an alternative memory architecture called Sync-Link DRAM (SLDRAM).

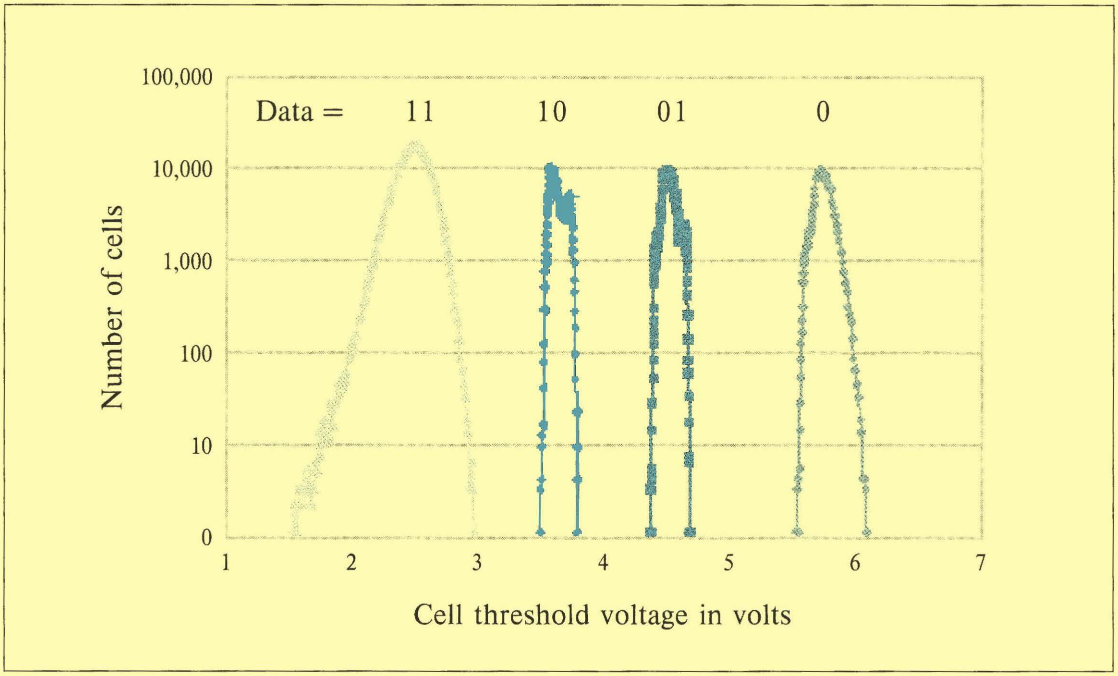
RDRAM is already being used instead of VRAM in some graphics accelerator boards, but it is not expected to be used for the main memory of PCs until 1999. Intel and Rambus are also working on a new version of RDRAM (called nDRAM) that will support data transfer speeds of up to 1,600 MHz.

The DDR (Dual Data Rate) RAM doubles its clock speed by transferring data on the up- and down-slope of a clock cycle. The synchronous static version (DDR-SSRAM) will be the choice for L2 cache RAM and is expected to run at clock speeds of up to 500 MHz.

2.3.1. Multi-level cell memory

A flash memory cell is a single transistor, which means that one bit of data is stored in one transistor; by comparison, a SRAM memory cell requires six transistors (or four transistors and two resistors), a DRAM memory cell requires one transistor and one capacitor, and an EEPROM cell requires two transistors. A single transistor has generally been considered to be the smallest practical unit for the storage of a bit of data but, in 1992, the Intel flash development team began exploring the possibility of reducing the amount of silicon required to

Figure 1
The threshold voltage distributions



Source: Intel

store a data bit to a fraction of a transistor by means of storing more than one bit in a single memory cell transistor.

The single transistor in a flash memory device includes an isolated floating gate capable of storing electrons. The behaviour of the transistor is altered depending on the amount of charge stored on the floating gate through a technique called programming. This programming operation generates hot electrons in the channel region of the memory cell transistor, and a fraction of these hot electrons gains enough energy to surmount the 3.2eV barrier of the $Si\text{-}SiO_2$ interface and becomes trapped on the floating gate.

In the case of single bit per cell devices, the transistor either has little charge (<5,000 electrons) on the floating gate and thus stores a "1", or a lot of charge (>30,000 electrons) on the floating gate and thus stores a "0". When the memory cell is read, the presence or absence of charge is determined by sensing the change in the behavior of the memory transistor due to the stored charge, which is manifested as a change in the threshold voltage of the memory cell transistor.

Figure 1 illustrates the threshold voltage distributions for a 500,000 cell (1/2Mc) array block. After erasure or programming, the threshold voltage of every memory cell transistor in the 1/2Mc block is measured, and a histogram of the results is presented. The erased cells (data 1) have threshold voltages less than 3.1 V, whereas the programmed cells (data 0) have threshold voltages of more than 5 V.

The charge storage ability of a flash memory cell is a key to the storage of multiple bits in a single cell. A flash cell is an analogue and not a digital storage device because it stores charge quantified at the level of a single electron rather than bits. By using a controlled programming technique, it is possible to place a precise

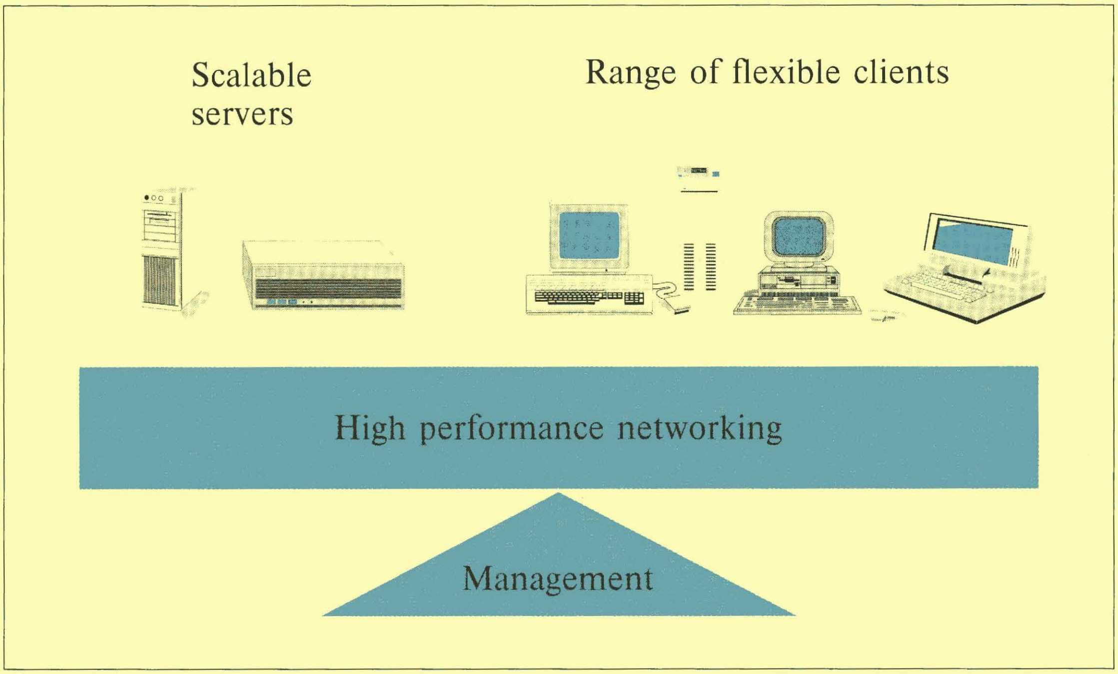


Figure 2
The architectural framework of modern systems

amount of charge on the floating gate. If the charge can be accurately placed to one of four charge states (or ranges), the cell can be said to store two bits because each of the four charge states is associated with a two-bit data pattern. Notice the precise control of the central two states, each of which is approximately 0.3 V (or 3,000) electrons wide.

Higher bit-per-cell densities are possible by controlling charge placement control even more precisely. A level of three bits per cell requires eight distinct charge states, and a level of four bits per cell requires sixteen. The number of states required is equal to 2 N, where N is the desired number of bits.

The ability to place the charge precisely on the floating gate and some time later sense the amount of stored charge has required substantial innovations and the extensive characterisation of cell device physics, memory design and memory tests.

3. Hardware platform technologies

This section relates to systems and peripheral hardware technology (i.e. computing platforms), excluding the telecommunications units considered in section 4.

The architectural framework of modern systems, which is driven by "network-centric" and "web-centric" paradigms (see *Figure 2*), is characterised by higher performance servers and clients interoperating via high-speed nets, and managed and controlled by increasingly smart and integrated management systems.

Although CMOS technology dominates all CPUs, and large system servers have CPUs that are very similar to those used for small servers and client systems, the technical evolution of clients and servers is moving in different directions on the basis of user needs: scalability, reliability and availability for servers; flexibility and mobility for clients. Nevertheless, both need an increasing level of manageability and have a common trend to increase communication speeds via new telecommunications interfaces.

Newly emerging application-specific systems include processor-based devices such as hand-held smart equipment, thin clients and the so-called information appliances, which are very easy to use application-specific computers for the home market: a first example is a television set equipped with an Internet access.

Increased mobile capacity, together with the greater availability of secure bandwidths, have led to the development of wearable computers that are currently used in the field by teleworkers, such as airplane technical support, hospital doctors, etc. The I/O is mainly provided by speech processing, with spectacles making a possible screen.

Interesting innovations included "ad hoc" peripherals not only for wearable computers, but also for more general virtual reality environments. A typical example is the new "force feedback" technology that adds vivid physical feel sensations to videogames, such as the simulated recoil of a fired gun or simulated vibrations when driving a car off-road.

Electronic commerce and greater security needs are increasing interest in and broadening the use of smart cards.

3.1. Server systems

Today's servers are mainly characterised by the activities they support in terms of platforms, configurations, multiprocessing, storage and computing power: the market is proposing "ad hoc" transactional servers, database and data warehouse servers, security servers, management servers, gateway servers, etc.

Large and medium-scale servers are technologically based on architectural solutions that allow a high degree of scalability and availability, together with high-speed processing and communication.

A common way of obtaining scalability and rapid processing is to use multiprocessing, the most widely used methods being Massively Parallel Processing (MPP) and Symmetric Multi Processing (SMP). With MPP, every CPU has its own memory; in the case of SMP, the CPUs share memory by creating a "virtual machine" capable of processing applications without modifications (see *Figure 3*).

Non-Uniform Memory Access (NUMA) architecture is used in some multiprocessor systems in order to overcome the limits of SMP architectures, which normally require very expensive solutions to exceed 16 CPUs, and the relationship between the number of processors and performance is not proportional.

Another way of achieving scalability (and availability) is "clustering", which makes a collection of loosely-networked computers function as if they were a single computer. By functioning as a single unit, clusters give an application access to infinitely more CPUs than a single SMP machine.

In addition to creating scalability, clustering also provides fault tolerance. If one of the machines within a cluster fails, the others can automatically take over its threads and processes, often without interrupting the user.

Most of the systems allow the use of Unix, TCP/IP and HTTP protocols, as well as the classical legacy operating systems.

A special point of interest is the availability of specialised (hardware or software) front-ends that make it possible to access traditional TP monitor applications from common web browsers.

The low-end range of servers includes low-end "minis", high-end workstations and LAN servers whose typology and architectural logic are very similar to those of low-end workstations and high-end PCs. Unix is offered in the majority of these systems and is in competition

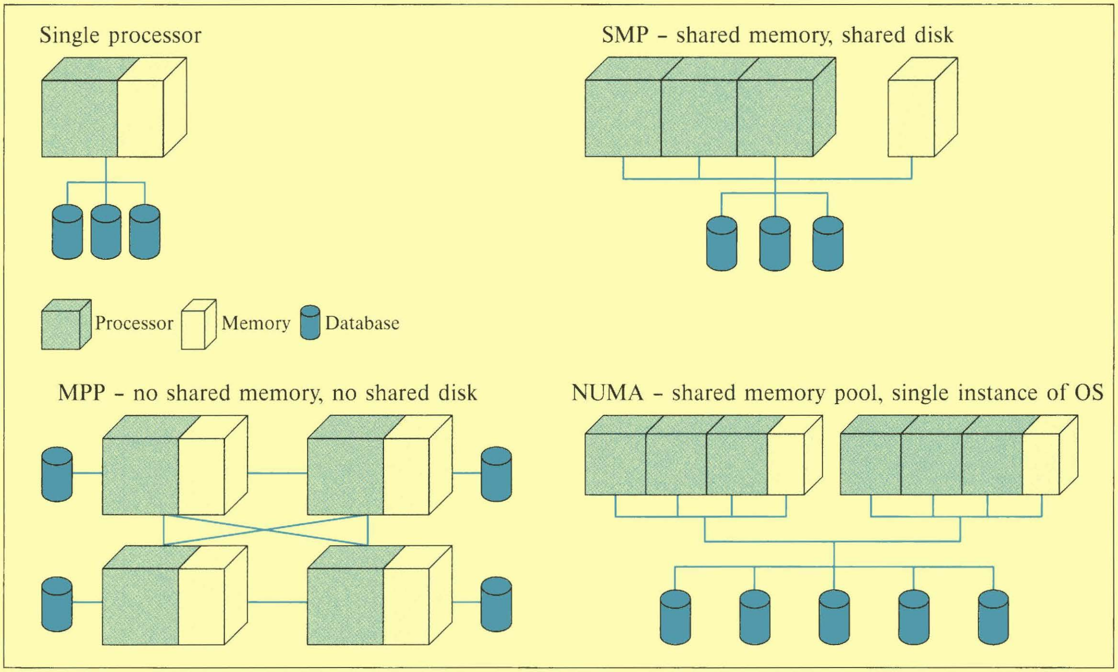


Figure 3
Server architectures

with legacy NOS, such as Netware by Novell [http://www.novell.com], OS/2 by IBM [http://www.ibm.com] and NT by Microsoft [http://www.microsoft.com].

3.2. Client systems

The kernel of this class is the personal computer (whose functional range can go from an X-terminal to a high-end multimedia workstation), but it also includes "stand-alone" equipment of all types ranging from desktops to hand-set systems. It is important to note that practically all types of system can be connected to a network and interchange information with other systems.

PC configurations and functions are going to become specialised for the business and home markets. There are two main categories of clients: portables (such as laptops, notebooks and sub-notebooks) and desktops, which include tower systems.

3.2.1. PC99 specifications

As PC hardware and operating systems advance, one of the biggest challenges is to synchronise these advances in such a way that the software can take full advantage of the hardware.

To ensure that PCs fully support new versions of "Windows-oriented" operating systems, a program has been established by several OEM manufacturers and Microsoft with the four objectives of synchronising hardware and software advances, increasing the quality and ease-of-use of PCs, reducing the total cost of PC ownership, and encouraging the incorporation of new technologies.

The "Designed for Microsoft Windows" guidelines are published in the "PC 99 System Design Guide" [http://www.microsoft.com/hwdev/download/desguid/PC99v1.zip].

PC99 contains several hundred guidelines for system design, bus implementation, and device design that cover microprocessors, memories, improved power management and Plug and Play functionality.

One of the more significant requirements is the elimination of Industry Standard Architecture (ISA) slots. Although some third parties (such as sound card makers) still build ISA products, these do not support plug and play, which means that their use adds complexity and the potential for glitches in Windows-based PCs.

Other requirements for business PCs are a minimum 300 MHz processor with 128 KB of integrated cache and support for Instantly Available PC, which defines power management guidelines for such things as the PCI bus, add-in cards and power supplies.

The companies are also recommending, but not requiring, that digital versatile disks (DVD) replace CD-ROMs as a storage mechanism.

3.2.2. Mainboards

With the advent of Pentium II CPUs, Intel switched to a proprietary physical interface called "Slot 1", whereas its competitors still use Socket 7 pushed to a bus speed of 100 MHz (Super7).

AMD has announced that its new K7 processor will adopt Digital's "EV6" Alpha bus protocol in a new 200 MHz interface called "Slot A".

In the meantime, Intel has announced a new socket for the low-cost Pentium family Celeron processors. This new socket will contain 370 pins and will not be compatible with Socket 7 because Celeron already has an L2 cache in the package and uses the P6 (Intel GTL+ bus protocol) instead of the Pentium bus. Finally, Intel is planning a new "Slot M" to support Merced and other IA-64 processors.

The result could be different competing PC architectures, which could lead to motherboard vendors having to create more versions of every product or choose sides.

3.2.3. Device Bay

Device Bay, which is receiving widespread industrial acceptance, defines an industry specification for interchangeable peripheral devices, such as hard disk drives, modems, network adapters, CD drives, DVD drives, etc.

The technology is being developed in response to customer wishes to be able to upgrade and customise their PCs and peripherals more easily. With Device Bay, a customer can insert a peripheral such as a DVD drive directly into a PC without opening, rebooting or turning off the PC.

Device Bay would use the existing, complementary industry interfaces: the Universal Serial Bus (USB) and IEEE 1394 High-Performance Serial Bus [EITO 97]. Additional information is available at [http://www.device-bay.org].

3.3. The evolution of system peripherals

3.3.1. The evolution of hard disks and their drives

Giant magnetoresistive (GMR) technology uses a different scientific effect than that used by the prevailing magnetoresistive (MR) head technology. By making more effective use of the spin properties of the electrons on a hard disk, GMR makes it possible to boost area density on drive platters to more than 10 billion bits per square inch (which would translate into 3.5-inch drives with a capacity of more than 13 gigabytes), as against the approximately 1.7 billion bits per square inch offered by the current MR drives.

Inside the hard disk industry, the "superparamagnetic limit" has defined the theoretical limit of how many bits of information can be crammed onto a disk. This limit has been shifted upwards to unexpected heights by means of constant refinement of disk surface storage structures and the use of new materials. This possibly soon-to-reached limit now seems to be about 20 billion bits per square inch.

In order to overcome this barrier some manufacturers are developing new combinations of existing hard disk (HD) and magneto-optical (MO) technologies. Optically Assisted Winchester (OAW) from Quinta (Seagate) [http://www.quinta.com] and Near Field Recording (NFR) from TeraStor [http://www.terastor.com/] seem to be ready to appear in some commercial products in 1999.

A further incentive for the development of high-capacity archiving systems comes from the network-centric paradigm, which concentrates and centralises storage on special high-capacity memorisation systems, thus allowing the information to be shared by several connected clients. This logic, which is known as Network-attached storage (Nas), was first used by LAN environments as an evolution of traditional file servers, and is now growing thanks to the Internet/Intranet phenomenon.

3.3.2. The evolution of CD-ROMs and DVDs

The evolution in the field of CD-ROMs is the introduction of speeds of up to 40X.

DVDs (Digital Versatile or Digital Video Disks) are a development of CD-audio and ROM laser disks and videotapes, which now provide 4.7 gigabytes and, in the future, will provide up to 17 Gb. The current standard promoted by the DVD Licenser Consortium, considers two main types of products: DVD Video TV peripherals and DVD-ROM PC peripherals. A DVD-audio is scheduled as a stereo system peripheral (even if this function is already a characteristic of the two previous classes). The physical size of the disks is 12 cm (like CD-ROMs) or 8 cm, and they can be single or double-sided.

The video format is MPEG-2, whereas the reference sound format is LPCM (Linear Pulse Code Modulation). Dolby Digital can be used as well as MPEG-2.

DVD-RAM is a rewritable DVD, that can erase and record data many times by using phase-change technology, which is based on a laser pulse that alters the crystalline structure of the disk in order to create a bit. Two rival standard proposals have been submitted to the European Computer Manufacturers Association [http://www.ecma.ch]: the first is promoted by the DVD Forum [http://www.dvdforum.org] and supports 2.6 GB per side (the next generation will support 4.7 GB); the second is sponsored by six large manufacturers and specifies rewritable disks with 3 GB per side.

3.3.3. Flat panel technologies

3.3.3.1. Field Emission Display (FED)

This technology may become the biggest threat to the LCD (Liquid Crystal Display) dominance of the panel display arena. FEDs capitalise on the well-established cathode-anode-phosphor technology built into full-sized CRTs (Cathode Ray Tubes), which they use in combination with the dot matrix cellular construction of LCDs. Instead of having a single bulky tube, FEDs use tiny 'mini tubes' for each pixel, with the display having approximately the same size as an LCD screen.

Each red, green and blue sub-pixel is effectively a miniature vacuum tube. Where the CRT uses a single gun for all pixels, a FED pixel cell has thousands of sharp cathode points (nanocones) at its rear made of materials such as molybdenum from which electrons can be very easily pulled by a voltage difference to strike red, green and blue phosphors at the front of the cell. Colour is displayed in terms of 'field sequential colour': i.e. all the green information is displayed, and then the screen is withdrawn adding the red followed by blue.

It looks as though FEDs have beaten already LCDs in a number of areas. As FEDs produce light only from the 'on' pixels, power consumption is dependent on the content of the display: this is an improvement over LCDs, in which all light is created by a backlight that is always on regardless of the image being shown. Furthermore, this backlight passes to the front of the display through the liquid crystal matrix, and its transmissive nature means that its distance from the front contributes to the narrow viewing angle; on the contrary, FEDs generate light from the front of the pixel and so their viewing angle is excellent - 160 degrees both vertically and horizontally.

FEDs also have built-in redundancy, with most designs using thousands of electron emitters for each pixel: whereas one failed transistor can cause a permanently on or off pixel on an LCD, FED manufacturers claim that FEDs suffer no loss of brightness even if 20% of the emitters fail.

These factors, coupled with faster than TFT (Thin Film Transistor) LCD response times and a colour reproduction equal to that of the CRT, make FEDs look a very promising option. However, they may be difficult to mass produce: a CRT has just one vacuum tube, but a SVGA FED needs 480,000; furthermore, in order to withstand differences between the vacuum and external air pressure, FEDs must be mechanically strong and very well sealed.

3.3.3.2. ThinCRT

This is the name that Candescent Technologies [http://www.candescent.com] has given to its implementation of FED technology. ThinCRTs work on the same principles as the standard picture tubes used by desktop computers and televisions: beams of electrons are fired from negatively-charged electrodes ('cathodes') through an evacuated glass tube, strike the phosphors at the front of the tube, and thus cause them to glow and create a high-resolution picture.

The difference is that, instead of the large bell-shaped tube required by conventional CRTs, ThinCRTs use a 3.5 mm flat tube that consists of two sheets of glass separated by a 1 mm gap. The internal display supports are very thin walls (e.g. 0.05 mm) made of a proprietary ceramic material, which are strong enough to handle 14 lbs. per square inch external atmospheric pressure (making them sufficiently durable to withstand mechanical handling during production) and yet thin enough to be hidden between pixels without affecting the electron beamlets. The face plate is coated with conventional CRT aluminised colour phosphors but, in place of the conventional single large cathode, there are millions of microscopic electron emitters formed on a baseplate using thin film processing technology similar to that used in LCD panel fabrication. Each emitter array is separately addressed to generate a multitude of electron beamlets that excite opposing phosphor dots.

This technology is called "cold cathode" because the electrons are generated at room temperature without the heating necessary in conventional CRTs, and so the emitters consume only a small fraction of the power used by hot cathodes: this leads to a very power-efficient display. Further power efficiency is gained as a result of the fact that a ThinCRT does not require the shadow mask used in conventional CRTs (and which can waste up to 80% of the power).

Candescent hopes to have produced the first ThinCRTs before the end of 1998, with volume production being scheduled for 1999 at a price comparable with that of TFT.

3.3.3.3. Light-emitting Polymers (LEP)

Of all of the display technologies emerging from the labs, the most widely important appears to be the use of light-emitting polymers (LEPs). Their developer and patent holder, Cambridge Display Technology (CDT), discovered that light can be emitted by applying a voltage across certain types of plastic. If LEP fulfils even half of the potential claimed by CDT, it promises to revolutionise everything from generic lighting technology to computer and electronic appliance displays.

LEPs are most closely related to the humble LED (light-emitting diode), but whereas the light producer of LEDs is a traditional semiconductor material, LEP uses special polymers to achieve the same effect. This technology has many potential advantages over LCD: only one sheet of plastic is required instead of two sheets of glass; there is no need for backlights, and so they consume less power; and, because the light is emitted from the LEP surface, wide viewing angles are possible. Furthermore, since they use flexible substrates, LEP displays can be curved and possibly even made to be flexible.

On the strength of these advantages, CDT claims that LEP screens will replace LCDs within the next few years. It is still early days to talk about real LEP products, but the promise is that they will cover an extremely wide range. Although CDT have so far only produced monochrome proof-of-concept prototypes, and notebook-size screens are not expected until 2004 at the earliest, the early LEP displays have been sufficiently impressive to tempt Intel to invest in the technology.

3.3.3.4. Digital Light Processors (DLP)

Texas Instruments' DLP - also called the mirror chip - is one of the most exciting innovations in display technology, as it has already been successfully exploited commercially. A mirror chip is fundamentally a standard static memory, with the memory bits being stored in silicon as electrical charges in cells over which a mirror-finish insulating layer is added and then etched out to form individual hinged flat squares. When a memory bit is set, the charge in the cell attracts one corner of the square and thus changes the angle of the mirrored surface; pictures can then be formed by bouncing light off this surface.

The drawbacks include the fact that complicated optics are needed to convert a picture the size of a postage stamp into a projectable display; heat is unavoidable, since a lot of light needs to be focused on the chip in order to make the final image bright enough; and a large amount of noisy ventilation is required to cool it (although the latest projectors do have the chip in a soundproof enclosure).

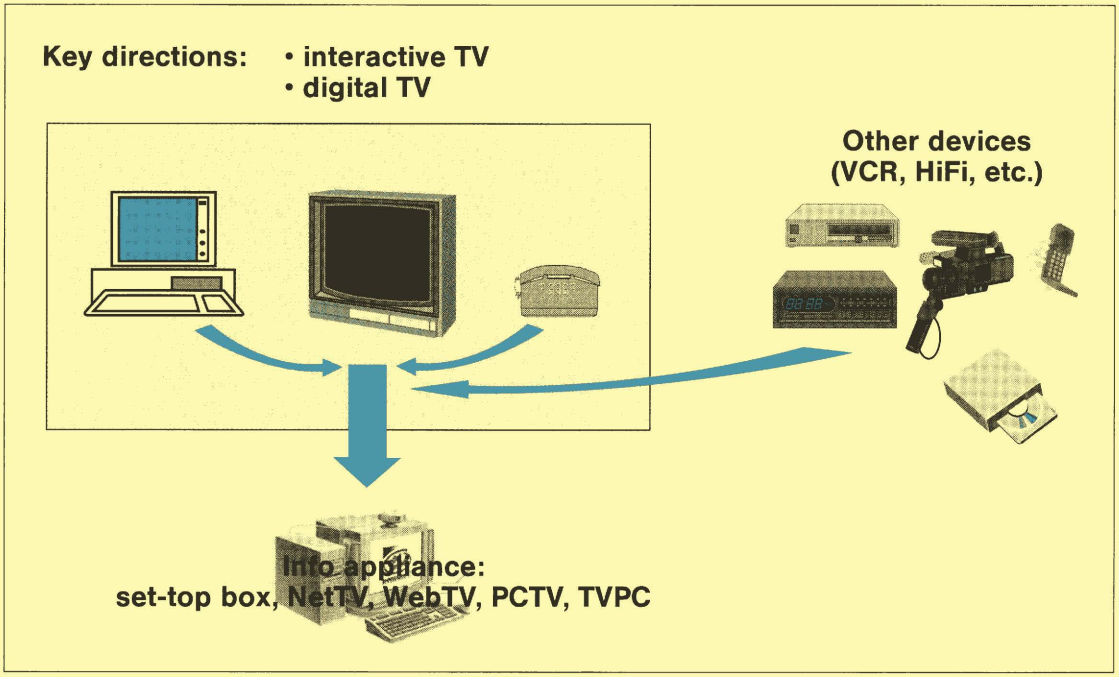
Colour is also a complication, since a mirror chip is basically a monochromatic device. To solve this, three separate devices can be used (each illuminated with a primary colour) or one device can be placed behind a rotating colour wheel with the chip displaying the red, green and blue components sequentially. The chip is fast enough to do this and the resulting picture looks fine on colour stills; however, there are still problems in handling moving images.

DLP development is continuing, and the current problems are likely to be solved in the future. Although mirror chips are currently only available in projectors, they are eventually likely to appear in a back-projecting desktop display.

3.4. Info appliances and new multimedia devices

Dominated by the Internet phenomenon, the convergence of ICT and consumer electronics is generating new classes of services and devices that are often generically referred to as *Information Appliances*. These consist of new consumer-focused, low-cost and easy-to-use digital electronic products that are primarily de-

Figure 4
Information appliances



signed to deliver the benefits of the Internet or an Internet-like service. Various devices will be put on the market, including set-top boxes, Net TVs, WebTVs, screenphones, Internet gaming consoles, Internet smart handheld devices, consumer network computers, etc. (see *Figure 4*) From a technical point of view, the convergence of cyberspace and TVspace (see also section 6.2.) is not simple, even if all of the systems are now based on CPUs. Just one example of this is the fact that the video screens used by the two worlds are different and not directly interchangeable: the current consumer television displays normally work at 2 MHz horizontally but the screens of PC users are commonly capable of resolving 20 MHz, which means that television viewers see interlacing and screen flicker effects.

This limits the amount of displayable information, particularly if we also bear in mind that television viewers usually look at their screens from distances that may lead broadcast regulators to argue that the smallest acceptable character size for readable text has to occupy 16 horizontal lines (whereas PC users are normally close to their screens). This may limit authoring to closer to 60 characters, and may mean that conventional WWW HTML documentation will have to be reliably mapped, for example, into television's MHEG standard.

The first set of info appliance products are TV-centric (set-top boxes, Net TVs, WebTVs or TVPCs), and use an NTSC or PAL television as their primary display. The interactive functions are provided by means of suitable intelligence integrated in the TV itself or in a separate box, interconnected to PSTNs or other coaxial or satellite communication services. The primary data input device is the remote control and a keyboard is normally an option. Other optional peripherals include existing TV-related products, such as VCRs and DVD players, together with different telecommunication interfaces and converter boxes. The introduction of digital TV and DVB (see also section 4.8.) will represent the natural evolution of these devices.

The second set of products is PC-centric, often called network computers or PCTVs: the primary display is the PC screen, and the device uses all of features and refers to all of the *de facto* and *de jure* standards of the cyberworld.

The third set of products comes from the evolution of videogame consoles which, either directly or by means of an add-on cartridge, provide access to the Internet, e-mail or Internet-like information services. Modern videogame consoles are already based on high-performance CPUs, 3-D graphics and CD-ROMs; the next generation already provides built-in modems for multiplayer gaming, software upgrade downloading, etc.

Another emerging product line is related to the evolutions taking place in the area of phone sets, including screenphones and smartphones. The former are high-end fixed telephones that integrate advanced telephone features, such as analogue display service interfaces (ADSI), caller ID, call waiting and voice mail, with electronic mail, online services and, in some cases, Web browsing. Smartphones are enhanced portable cellular phones that enable both voice and data communications. They can both also provide other features such as calendaring, personal memos, and lists of names, addresses and phone numbers.

The fifth line derives from the evolution of handheld intelligent devices, such as personal digital assistants (PDAs), PC and personal companions. The characteristics of this category include the use of these devices as supplements to desktop or portable PCs, and they will soon be capable of making Internet connections. Some of these devices are customised for vertical applications in a variety of industries: e.g. route delivery data collection for vendors in the transportation industry or physicians accessing patient records in a hospital.

The ability to manage multimedia information is a growing requirement for all ICT equipment, although not everyone wants all of the possible functions integrated on the same device. Web browsing is a basic function but, as described in sections 5. and 6., different standards are emerging from the cyber and the TV worlds, which are in some cases complementary and in others competing (the most important are MPEG-2 and -4, MHEG, HyTime and SMIL).

3.4.1. Multimedia Home Platform (MHP)

This is a set of standards published by the ETSI as TS 101224 that fall within Davic architecture logic and have the main goal of running applications on advanced set-top boxes, TV sets and multimedia PCs for digital broadcasting. The physical and transport layers of the MHP are based on DVB and mainly concern the higher layers for interfacing application services.

The concept of a multimedia home platform encompasses the "local cluster" of in-home multimedia devices and network connections with broadcast and online services. The "home network" is defined as the "In-Home Digital Network" (IHDN), which is subdivided into the Home Access Network (HAN) for connection to external networks and the Home Local Network (HLN; based on IEEE 1394) for interconnecting user equipment to clusters and between rooms.

The access technologies are based on DVB (DVB-S, DVB-C, DVB-T, DVB-SMATV, DVB-MC, DVB-MS), and the interaction (return) channels on PSTN/ISDN, CATV, LMDS, DECT, GSM. These are complemented by the Network Independent Protocols (NIPs) based on MPEG-2 DSM-CC (Digital Storage Media – Command and Control).

As pointed out above, MHP mainly refers to hyper-multimedia applications, particularly "enhanced digital broadcasting" applications with or without an interactive return channel, and normal online Internet access. For example, the applications could include a content or event-orientated Electronic Programme Guide (EPG) and a more service-oriented navigator, with both using browser-like Graphical User Interfaces.

The MHP specifications include a receiver application programming interface (API), download mechanisms for applications, software, and related functions.

The already-defined generic API elements include the DVB-SI API, the DSM-CC (Digital Storage Media - Command and Control) API, the MHEG-5 (Multimedia & Hypermedia Experts' Group) API, the Java embedded system API, and the MPEG-2 Section Filter API, which carries private data and a subset of Java.

3.4.2. Digital TV and High-definition TV (HDTV)

All of the European countries have agreed to adopt the DVB standard (see 4.8.), which is largely based on MPEG-2 video compression. Europe will finally have a single TV standard instead of the medley of incompatible analogue systems associated with Secam and PAL (the television systems used in the various parts of Europe and the ex Soviet bloc).

The US approach began by a high-resolution platform based on computer screen standards, whereas Europe's DVB system derives from the existing 625-line, 50 Hz analogue TV standard used in both the PAL and Secam systems. High-definition television (HDTV) will be simultaneously broadcast in European countries when and only when enough consumer demand materialises.

Furthermore, the US Federal Communications Commission (FCC) has allocated 6 MHz channels for digital HDTV, whereas European broadcasters have the luxury of the 8 MHz that is the current analogue allocation needed to accommodate Europe's 625 lines. In terrestrial broadcasting, each 8 MHz channel can carry a data stream of about 24 Mb/s; using today's coding technology, this can be divided into 4 Mb/s streams for six simultaneous programmes - or perhaps twice as many in the future with the aid of statistical multiplexing.

The main differences between these standards lie in the way they package compressed signals for transmission. The DVB standard for satellite transmission is based on quadrature phase-shift keying modulation, whereas cable uses quadrature amplitude modulation. Both resemble the systems used for sending high-speed electronic mail over analogue phone lines, insofar as the analogue wave is switched through several levels to represent blocks of bits. At the same time, the wave is duplicated and its replica transmitted out of phase with the original, and independently switched in level or phase to increase the total number of bits conveyed. Digital terrestrial TV uses coded orthogonal frequency-division multiplex, with the signal being spread over several thousand narrow channels in such a way that each carries a low data rate. Unwanted reflections arrive in the wide gaps between the segments of direct signal code, and are thus rejected by the receiver.

The DVB definition format uses the same 625 scanning lines, interlaced at the same 50 fields per second as those used in by PAL and Secam. In the case of HDTV, resolution is doubled to 1,250 scanning lines, with an option for the progressive scan used by all computer displays.

For audio standards, the USA, together with Canada and South Korea, have selected ATSC (Advanced Television Standards Committee) for the Grand Alliance standard; Mexico and Taiwan the AC-3 (Dolby Digital system) that records six discrete sound channels; and Europe (via DVB) the MPEG-2 sound that provides six sound channels.

3.5. Smart cards

Smart cards refer to a wide range of technologies, all of which are based on ICs in order to provide persistent and portable information storage. The most recent microprocessor cards are "smarter" than the older simple memory and 8-bit cards because they incorporate a 32-bit RISC processor running at 25-30 MHz, and have multi-application operating systems.

In addition to the ISO 7816 standard for polyvinylchloride (PVC) contact cards, which specifies their physical dimension with a thickness of 0.76 mm, the different solutions on the market are mainly proprietary, and there is a major lack of a standard for interoperability. The Global Chipcard Alliance [http://www.chipcard.org], together with other industry standard groups and fora, are trying to establish common standards, the most significant proposals for which include EMV, C-SET and JavaCard.

The Europay-MasterCard-Visa (EMV) proposal defines the "Integrated Circuit card specifications for payments systems", now at version 3.1.1 [http://www.visa.com/cgi-bin/vee/nt/chip/download.html].

The Card-Secure Electronic Transaction (C-SET) proposal combines SET [www.mastercard.com/set/] architecture and protocols with the use of a chip card for user validation. Currently still in the prototype phase, C-SET may play a significant role in Internet E-commerce.

JavaCard is a Java language version for smart card operating systems. Now at version 2.0, this specification allows the inclusion of a Java Virtual Machine (JVM) in the card operating system, and therefore provides a common interface for any downloaded Java applet. A JavaCard Forum [http://www.javacardforum.org] has been formed by Visa, and MasterCard has promoted another consortium [http://www.multos.com], with the aim of developing a non-proprietary open platform called MultOS. Microsoft has announced its own smart card programming standard: the Smart Card Software Development Kit (SCSDK).

4. Telecommunications

Telecommunications technologies and nets represent one of the basic infrastructures for ICT and the Information Society, and R&D efforts are mainly focused on increasing the bandwidth (i.e. the amount of information in a time unit) required by growing multimedia needs, and on ensuring ubiquitous distribution and access.

All of the key innovative TLC technological trends described in previous EITO reports have now come about, leading to a gradual deployment and diffusion that may differ from country to country particularly in terms of public networks. The main factors driving the increasingly greater integration of voice, data and video (also within the Internet world) are still:

- the growing speed and capacity of Wide Area Networks (WANs), Local Area Networks (LANs) and local accesses (last mile);
- the extended use of mobile systems, and their growing integration with fixed systems;
- the dominance and spread of Internet protocol stacks and the World Wide Web (WWW), as Internet/IP logic and addressing schemes are unifying and standardising TLC architectures and services for both public and private networks.

New services and new user behaviours are completely changing TLC traffic patterns: e.g. Internet connections last several times longer than average telephone calls; E-commerce and credit card transactions require very short connections (an average of one second); the growing number of mobile connections (particularly for cellular telephony) have significantly increased traffic in access areas. Telephone traffic is becoming more similar to that of computer networks, which means that telephone network structures have to become substantially different. The basic reference model is that of the Internet, in which connections and interactions with information providers are established directly from home terminals using the network as a transparent, reliable broadband and low-cost transport medium. The Internet model is simple because each new service is independent of the existing range, can be provisioned from any network access point and accessed by anyone. But the IP network cannot simultaneously carry voice and data, and still guarantee quality service in terms of availability and response times. Differentiated services enable routers to set prioritisation fields in IP packets, and Multi-Protocol Label Switching (MPLS, see 4.2.1.) will provide "fast tracks" for IP packets across the backbone. However, these two specs still needed to be formally standardised, whereas ATM can already provide QoS via the Resource reSerVation Protocol (RSVP) and Class of Service (COS).

Some TLC manufacturers have developed proprietary technologies that allow different priority IP traffic (including voice traffic) to be carried over the corresponding ATM service class.

The public and private networks already in operation (which continue to carry traffic and in which a lot of money has been invested) should not so much be considered a constraint, but rather as representing an operational infrastructure that will evolve as a result of their integration with new technologies or the creation of additional parallel (overlaid) infrastructures. The logical consequence is a common tendency to "mix" new and old technologies. Coexistence is just as much a watchword as multimedia/digital convergence, and will have an impact on all of the new network architectures. Another key word, in addition to *convergence* and *coexistence,* is the *flexibility* that will allow the infrastructure to be used in a variety of ways by means of the dynamic creation of a number of virtual networks, and make it possible to add new services easily in order to respond as rapidly as possible to changing needs. As also discussed in the EITO 98 report, the new TLC services, systems and products are and will continue to be "hybrids" of different technologies and techniques.

4.1. The evolution of fibre optics and transmission techniques

Some of the key factors driving the migration to optical fibres in both public and private networks are:

Fibre capacity: New techniques such as Wavelength Division Multiplexing (WDM) and Dense Wavelength Division Multiplexing (DWDM: see. 4.1.1.) turn a single physical fibre into many "virtual" fibres by allowing network providers to transmit signals simultaneously at a different frequency as if each were travelling on its own fibre. The performance of WDM is now 40 Gbit/s per fibre-pair, and DWDM will boost bandwidth to 800 Gbit/s by the year 2000.

Restoration capability: By implementing optical networks, providers can add restoration capabilities to embedded asynchronous systems without first upgrading to an electrical protection scheme; optical networks can provide protection switching more rapidly and more economically.

Reduced costs: Only the wavelengths that add or drop traffic at a site need to have corresponding electrical nodes; other channels can simply pass through optically. This not only leads to enormous cost savings in equipment and network management, but the space and wavelength routing of traffic avoids the high cost of electronic cross-connections and also simplifies network management.

Wavelength services: Optical networks can resell bandwidth rather than fibre. By maximising the available fibre capacity, service providers can improve their revenues by selling wavelengths regardless of the data rate required, and customers receive the same bandwidth as with a dedicated fibre.

The main innovations relating to optical fibres concern better use of the available capacity: increasing it where possible and/or sharing it among several users on the basis of the assumption that not everyone needs all of the resources at the same time. Multi-wavelength optical multiplexing and high-speed optical time domain multiplexing (OTDM) are increasing the already huge capacity of the fibres themselves.

These innovations provide cost-effective and practical network units, including tunable filters, space switches, amplifiers, de-/multiplexers, and wavelength converters and selectors.

In addition to DWDM, the most advanced technologies currently used in fibre nets are:

Optical amplifiers, which have significantly less noise and a flatter gain; total power has also increased and outputs are now approaching +20-dBm, many orders of magnitude more powerful than those of the first amplifiers.

Narrowband lasers: Optical components require a narrow, stable and coherent light source that is provided by means of advanced lasers, which emit a highly coherent signal that has an extremely narrow bandwidth.

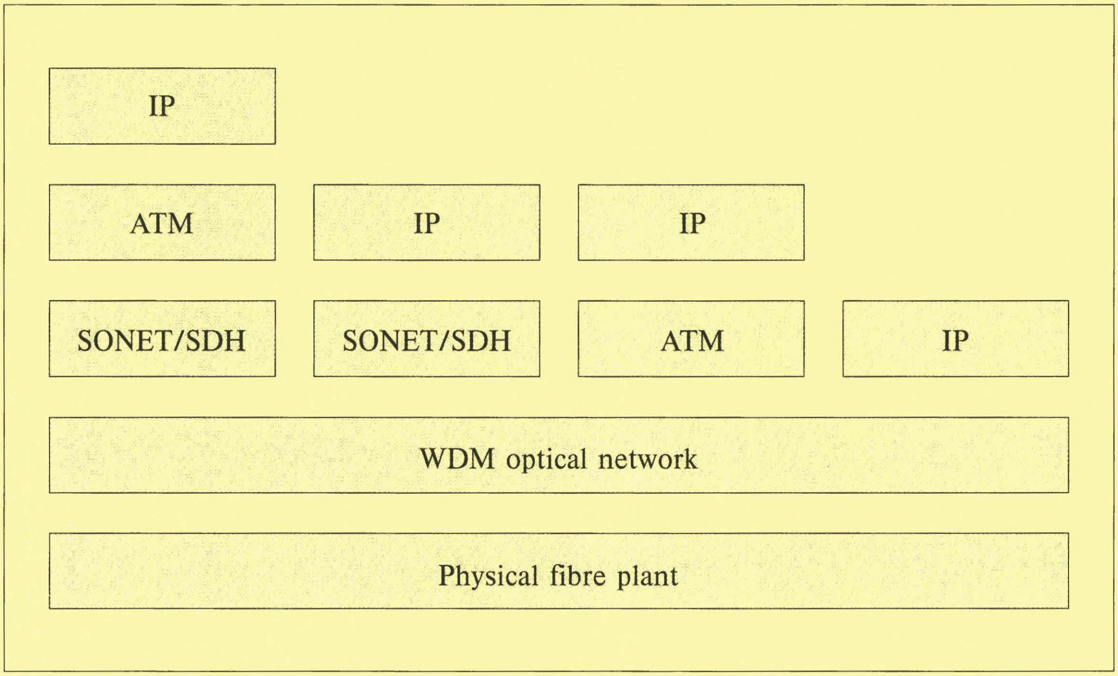
Fibre Bragg gratings: These consist of a small section of fibre that has been permanently modified to create periodic changes in the index of refraction, generally by exposure to an ultraviolet interference pattern. Depending on the space between the changes, a certain frequency of light – the Bragg resonance wavelength – is reflected backwards while all of the other wavelengths pass through. The result is a component that acts as a wavelength-dependent reflector and is useful for precise wavelength separation. The fibre grating creates a highly selective, narrow bandwidth filter that functions somewhat like a mirror and provides significantly greater wavelength selectivity than any other optical technology. The filter wavelength can be controlled during manufacture by means of simple geometric considerations that enable reproducible accuracy. Because this is a passive device built into the glass fibre, it is robust and durable. The wavelength-specific properties of the grating make fibre Bragg gratings useful in implementing optical add/drop multiplexers. Bragg gratings are also being developed to aid dispersion compensation and signal filtering.

Thin film substrate: This substrate can be made to allow the passage of only one specific wavelength and reflect all of the others by coating a fine glass or polymer substrate with a thin interference film of dielectric material. By integrating several of these components, many optical network devices can be created including multiplexers, demultiplexers and add-drop devices.

Semiconductor optical amplifiers (SOA): These integrate amplifier functionality into the semiconductor material, and allow the same basic component to perform many different applications. They can reduce costs and improve performance by integrating internal switching and routing functions; they can also be used for space switches, wavelength converters and wavelength selectors, all of which will lead to large-scale optical network equipment in the future.

The effort to accelerate the implementation of these next-generation optical networks is supported by the Optical Internetworking Forum (OIF) [http://www.oiforum.com], which mainly concentrates on optical internetworking

Figure 5
OIF (Optical internet-working overlay model)



Source: OIF

issues by addressing the interoperability between data and optical networks (see *Figure 5*). As D/WDM optical nets use physical and data nets use logical paths, it is necessary to create associations between them in order to enable their management and adaptation, interlayer independence, interface transparency, layer flexibility (IP or ATM over Sonet/SDH; IP or ATM over WDM/DWDM), interlayer coordination and dynamic bandwidth provisioning.

4.1.1. Dense Wavelength Division Multiplexing (DWDM)

The growing demand for bandwidth is being met by the parallel and integrated use of Dense Wavelength Division Multiplexing (DWDM), Erbium-Doped Fibre Amplifiers (EDFA), precise demultiplexers and Optical Add/Drop Multiplexers (OADM).

The majority of the currently used fibre optic cables operates in time division multiplexing (TDM) at 2.4 Gbps on a single fibre, with some deploying equipment that quadruples the rate to 10 Gbps: carriers in the USA and Europe operate according to Sonet and Synchronous Digital Hierarchy (SDH) standards, which are functionally equivalent. Synchronous Transfer Mode (STM) describes the SDH rates, in particular STM-16/OC-48 for 2.4 and 8 Gbps and STM-64/OC-192 for almost 10 Gbps.

As also pointed out in EITO 1998, DWDM multiplies the simple 2.4 Gbps system by up to 16 times, thus providing an immense and immediate increase in capacity – using embedded fibre! A 16-channel system (already available) supports 40 Gbps in each direction over a fibre pair, whereas a 40-channel system currently under development will support 100 Gbps, the equivalent of ten STM-64/OC-192 transmitters!

DWDM technology uses a composite optical signal carrying multiple information streams, each transmitted on a distinct optical wavelength. Although wavelength division multiplexing is a technology that has been known for a number of years, its early application was restricted to providing two widely separated "wideband" wavelengths, or manufacturing components that separated up to four channels. It is only recently that the technology has evolved to the point at which parallel wavelengths can be densely packed and integrated into a transmission system by using multiple, simultaneous, extremely high frequency signals in the 192 to 200 terahertz (THz) range. In conformity with the ITU channel plan, this system ensures interoperability with other equipment and allows service providers to deploy optical solutions throughout their networks. In essence, the 16-channel system provides a virtual 16-fibre cable, with each frequency channel serving as a unique STM-16/OC-48 carrier.

The most common form of DWDM uses a fibre pair (one for transmission and one for reception): for example, to transmit 40 Gbps over 600 kms using a traditional system would require 16 separate fibre pairs with regenerators placed every 35 kms for a total of 272 regenerators, whereas a 16-channel DWDM system uses a single fibre pair and four amplifiers positioned every 120 kms.

The commercial deployment and use of the DWDM technique is also made possible thanks to the availability of suitable demultiplexers, Optical Add/Drop Multiplexers and Erbium-Doped Fibre Amplifiers.

The precise and dense signals used in DWDM require accurate signal separation (or filtration) on the optical receiver in order to avoid or limit the problems of traditional filters, which are expensive, imprecise, sensitive to variations in temperature and polarisation, and vulnerable to crosstalk.

High performance and high quality filtering is now provided by a technology named "in-fibre Bragg grating".

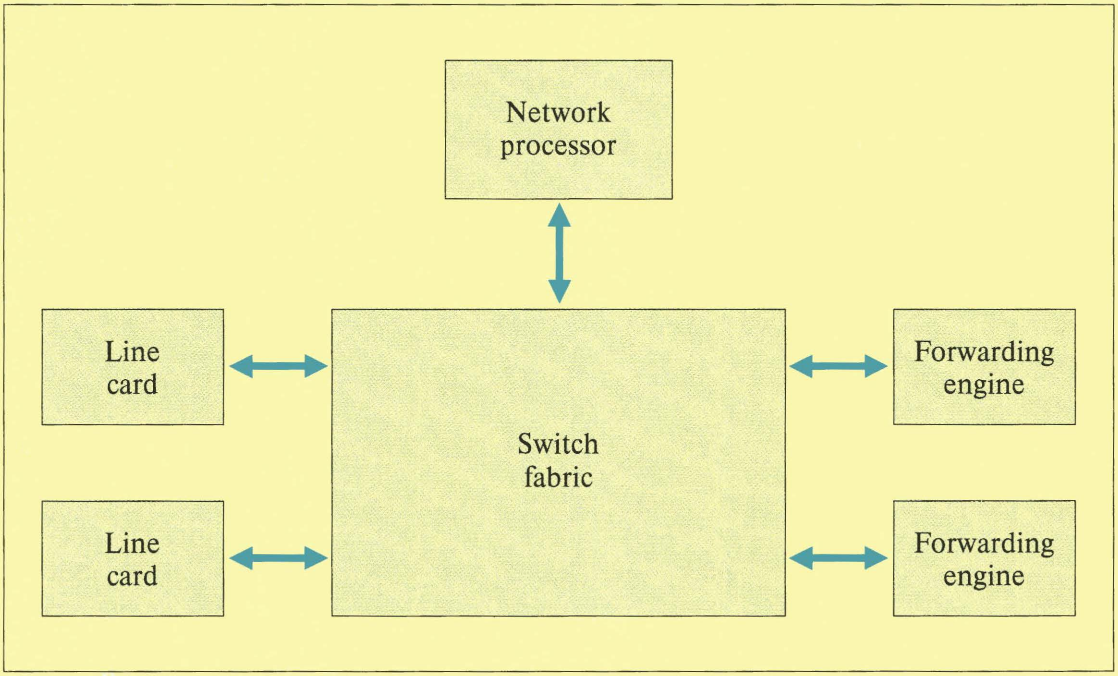
EDFAs optically amplify all of the wavelengths at the same time because they incorporate erbium ions into the core of a special fibre optical pump. Lasers are used to transfer high levels of energy to the special fibre and thus energise the erbium ions, which then boost the optical signals that are passing through. Significantly, the atomic structure of erbium provides amplification to the broad spectral range required for densely packed wavelengths operating in the 1,550 nm region by optically boosting the DWDM signals. Unlike the multiple electronic regenerators that required the conversion of optical to electrical signals and then their reconversion back to optical signals, EDFAs amplify the optical signals directly, which is why the composite optical signals can travel further without regeneration.

Fibre Bragg grating, EDFA and DWDM techniques are integrated through the use of Optical Add/Drop Multiplexers (OADMs) and net management tools capable of operating in conjunction with other Operation Support Systems (OSS) complying with the ITU's Telecommunications Management Network (TMN) standard.

The commercially available OADMs allow carriers to drop and/or add up to four STM-16/OC-48 channels between DWDM terminals. Certain wavelengths can be passed through the node uninterrupted (express channels) or broadcast on up to four channels to be dropped and simultaneously continue as "express channels".

DWDM is considered a significant step toward the establishment of photonic networks in the access, interoffice and interchange segments of today's telecommunications infrastructure.

Figure 6
Typical structure of a high-speed router



Source: Ipsilon

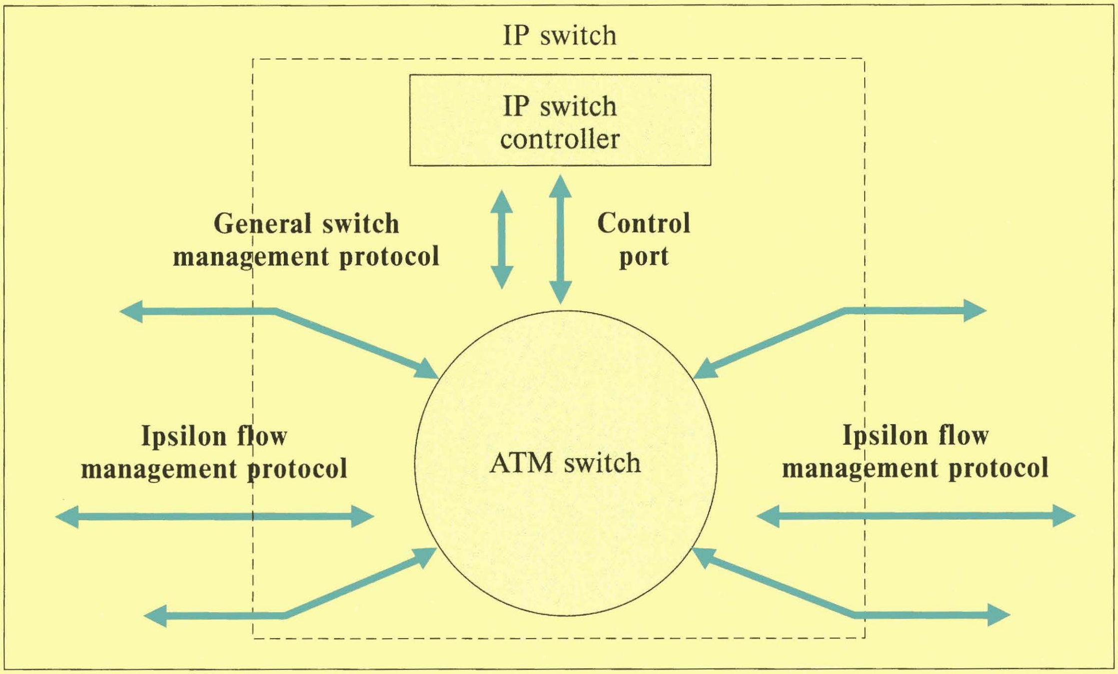
4.2. Routers and switches: new network units

A new generation of "high-speed" network units for both private and public networks is providing multi gigabit and terabit routers and ATM switches with a growing level of flexibility, configurability and scalability by means of a mix of old and new protocol stacks and routing logics. Since the new and old public nets will coexist, the Signalling System 7 (SS7) standard set of protocols has been developed not only in public net nodes, in order to enable value-added voice services and applications over both circuit- and packet-based nets.

These units are based on ASIC components and the mainly object-oriented software plays a key role in their operation and management. Segmented, shared and switching hubs, as well as port, layer 3 and multilayer switches, are the evolving products for both public and private nets, LANs and WANs. The main innovatory efforts concern high-speed routers (now at the tera and giga bps level), layer 3 high-performance switching (which also handles routing functions in hardware) and peer-to-peer multi-layer switches that map Layer 3 (IP) addresses to Layer 2 destination addresses.

Figure 6 shows the general structure of a high-speed router. The line cards interface the external lines, the forwarding engines manage the packet headers according to the route decisions for sending the packets to the suitable line, the network processor supports the routing and tables, the switch fabric internally connects all of the components. For the fabric switch, the top level routers deploy cross bar or ATM switches capable of managing several Gbps.

Over the last few years, semantic differences in the use of the term IP traffic "switching" (and therefore also the term "router") have generated



Source: Ipsilon

Figure 7
IP switch structure

some confusion. Switching is generally used to describe the transfer of information from an input to an output port of a machine, with the selection of the output port being based on a Layer 2 address scheme. The problem is how to handle IP traffic over public and private networks with a given quality of service using the new high-performance routing protocols. The IP hop-by-hop packet forwarding paradigm will be insufficient to support high-speed needs, and traditional routers may become a bottleneck.

Switches are like high-capacity bridges for broadband nets, with the switching functions being performed in hardware via ad hoc ASIC and using MAC-Layer 2 addresses.

Layer 3 switching adds router capacity to switches, thus combining high performances, lower costs (in comparison with high-speed routers) and the deliverability of packets to destination addresses.

Some of the key innovations are based on the evolution of IP switching logic and provided in different ways by the major manufacturers. A number of protocols have been proposed, but none of them has yet been formally standardised.

The reference technologies are (see also [http://www.cis.ohio-state.edu/~jain/cis788-97/ip_switching/] and linked references):

IP switching was developed by Ipsilon [http://www.ipsilon.com], and is also used in the products of other manufacturers. The Ipsilon IP switch uses ATM switching hardware for directing IP datagram traffic, and for controlling and managing the path and the switches via the proprietary Ipsilon Flow Management Protocol (IFMP) and the General Switch Management Protocol *(Figure 7)*. It uses low-level flow switching that is equivalent to cached routing decisions. All of the flows are classified, and this dynamically selects the flows to be forwarded in the switch fabric while leaving the remaining flows to be forwarded hop-by-hop. In addition to the problem of congruency with the present ATM Forum standards, other critical questions relate to the quantity of traffic and flows to be analysed. A similar approach has been considered in the case of Toshiba's Cell Switched Router (CSR) [http://www.toshiba.com], which merges the IP over ATM cell switching mechanisms and the new additional functions for IP provided by protocols such as RSVP. CSRs extend the capacity of current routers to handle resource reservation and IP flows using ATM cell switching capabilities.

Flow switching is provided by Cisco Tag Switching [http://www.cisco.com], with similar but different schemes also being offered by IBM's Aggregate Route-based IP Switching (ARIS) [http://www.ibm.com] and 3Com's Fast IP [http://www.3com.com].

Tag switching: A layer 3 router called a Tag Edge Router decides the best route for a flow, establishes the virtual connection and appends a "tag" (a small string of bits with routing information) to the IP packets entering the backbone network; the Tag Switches within the virtual connections follow the tag information and do not make any routing decisions. Each Tag Edge Router and Tag Switch uses a Tag Distribution Protocol to create and manage a Tag Information Database. Tag Switching logic is the core of the IETF's effort to standardise Multi-Protocol Label Switching (MPLS: see 4.2.1.).

Fast IP: This approach is based on the identification of the different IP flows, which are made to by-pass the routers by means of the Next Hop Resolution Protocol (NHRP). This proprietary protocol, which is currently being evaluated by the IETF, is intended to locate an exit point in the ATM cloud closest to the destination and obtain its ATM address; an NHRP server then provides the next hop towards the destination. The NHRP servers interact with each other in order to discover the exit point closest to the destination.

ARIS establishes a set of switched paths in the ATM network and uses the binding of labels to the switched paths for switching packets.

4.2.1. Multi-Protocol Label Switching (MPLS)

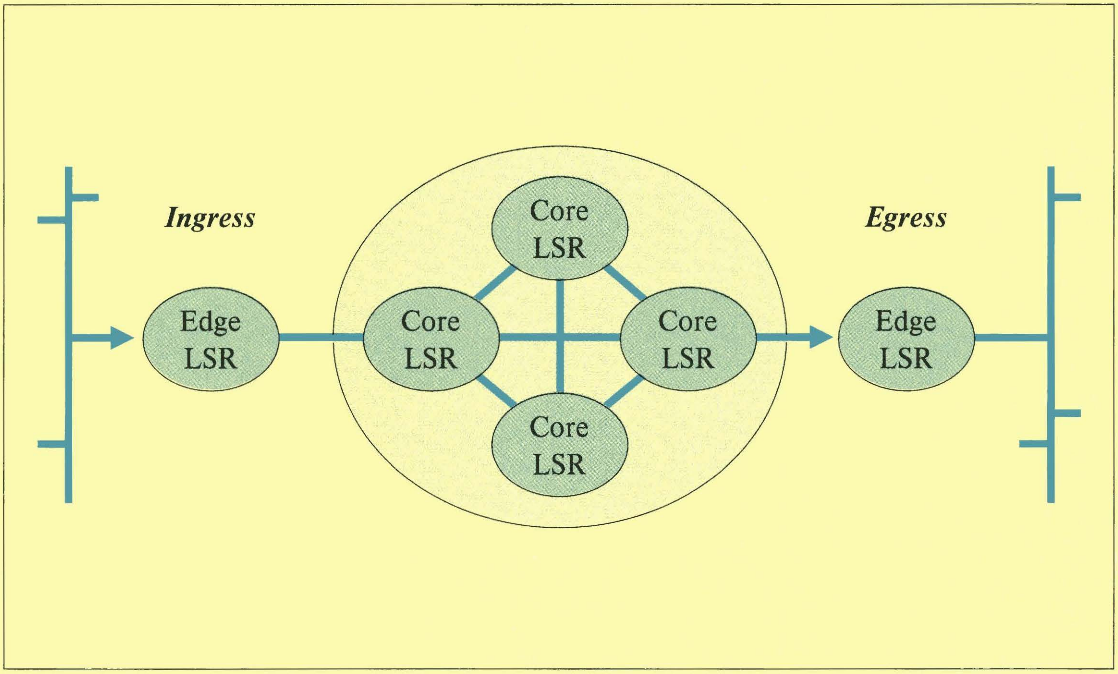
The IETF MPLS Group is standardising an interoperable standard called MPLS for the integration of layer 2 switching (based on label swapping) to layer 3 routing in order to improve the price/performance of network layer routing, the scalability of the network layer and the flexibility of new routing services.

Although MPLS focuses on IP, it can be extended to other network layer protocols. No assumption is made about layer 2 protocols except for the fact that they are capable of forwarding network layer packets.

Label switching technology development is driven not only by the need for speed, but also by the need to manage different classes of traffic with specific service characteristics that must be guaranteed across multi-customer, carrier-class IP infrastructures.

MPLS defines labels as relatively short, fixed-length unstructured identifiers that can be used to assist in the forwarding process. They are normally local to a single data link and, unlike an address, have no global significance; they are analogous to the DLCIs used in a Frame Relay network or the VPI/VCIs used in an ATM environment. Since ATM is a technology that already uses short fixed-length fields to make switching decisions, label switching is believed to be an effective way of deploying IP over ATM.

A Label Switching Router (LSR) is any device that supports both the standard IP control component (i.e., routing protocols, RSVP, etc.) and a label swapping forwarding component.



Source: The Applied Technology Group

Figure 8
The structure of a MPLS network

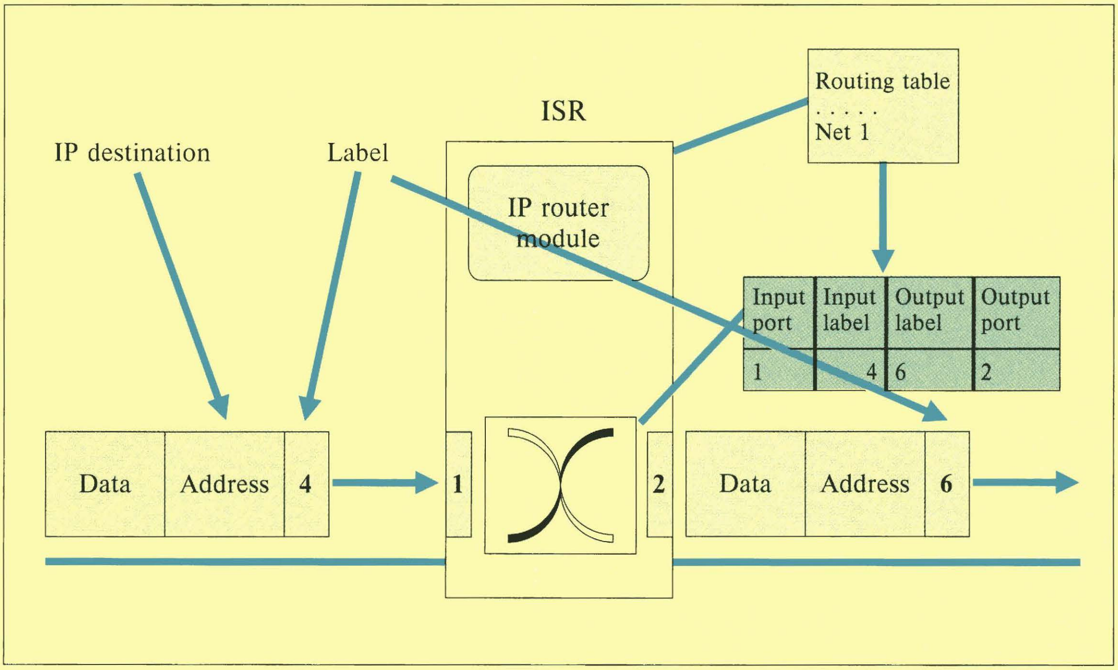


Figure 9
Label swapping scheme

Figure 8 shows a simple label switching network made up of Edge LSRs, which provide ingress and egress functions, and the Core LSR for high-speed switching. A label can be associated with a packet by embedding it in the Data Link Layer header or adding it as a specific field between the Data Link header and the Data Link protocol-data-units. As a result, the label can be supported by virtually any Data Link protocol.

At the boundary of an MPLS network, the Edge LSRs make classification and forwarding decisions on the basis of the IP header in the unlabelled packets; the appropriate labels are then added and the packets forwarded to an adjacent LSR. The label acts as a short IP packet header, thus reducing the forwarding process at all subsequent nodes in the path. When a core LSR receives a labelled packet, the label is extracted and used to find the outgoing destination via the local forwarding table; the incoming label is replaced by the outgoing label, and the packet can then make the next hop (see *Figure 9*).

MPLS allows a label switching forwarding table to be at the level of the node (one table per node) or interface (one table per interface).

Label information can be distributed by piggy-backing on pre-existing routing protocols (provided that these allow label handling) or by means of the new Label Distribution Protocol (LDP) whose version 1.0 is about to be completed.

4.3. The evolution of public networks

As a result of technological innovations, changing traffic profiles, and liberalisation and re-regulation processes, public networks are undergoing a significant metamorphosis that requires a change from the now old "voice-oriented" nets based on circuit switching, to the new public packet- and cell-based infrastructure that is equally capable of handling all types of information.

Multimedia convergence, and the coexistence and flexibility of technologies, are also the strategic guidelines governing the public network arena. The main reference is Telecommunications Information Networking Architecture (TINA: see EITO 98 and [http://www.tinac.com]) specified by the related Consortium TINA-C. TINA also introduces a "second-generation" Intelligent Network (IN) characterised by Service Creation Environment (SCE) standard protocols in order to ensure interoperability between the switching and IN units, and Service nodes that will act as servers for highly interactive and multimedia services. Unix, HTTP-TCP/IP and CORBA are the reference platforms for these units.

The main carriers have to adopt "open" scenarios in order to make the nets accessible to third parties, as required by the liberalisation and re-regulation processes.

QoS (Quality of Service) is becoming an increasingly key function for delivering different types of traffic at different service classes and different prices, as well as for satisfying application requirements such as response time. Although only ATM is currently capable of supporting these key functions, IP is catching up fast and the main carriers are logically deploying both technologies.

The main technical innovations in the new public networks, which are conceptually described in *Figure 10,* concern all of the architectural parts (from the back-bone to transport services, from the local loop/head-end to customer premises) including:

Integrated access devices (IADs): At customer premises level, IADs integrate voice and data traffic on a single access line and functionally incorporate a router, bandwidth manager, VPN,

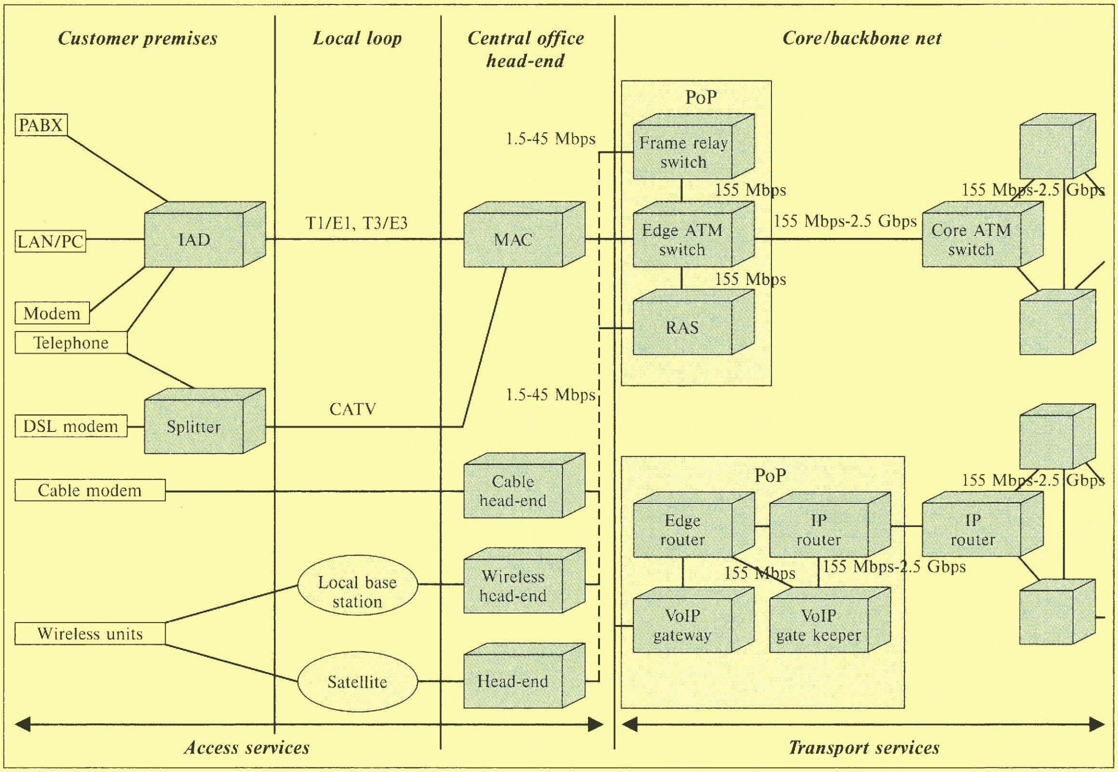


Figure 10
The basic structure of the new high-speed public network

PBX, VoIP. They can also provide various QoS functions. Equipped with DSL modems and CSU/DSUs, they are supplied and managed by carriers but located on customer premises. An IAD is more than a superconcentrator as it increases or decreases application bandwidth in response to end-user requirements. A number of vendors are currently selling products that can be classed as IADs.

Frame distributor/splitters: These split different xDSL circuits into data and voice circuits at central office/head-end level.

Multiservice access concentrators: At central office/head-end level, these concentrate xDSL and leased lines, converting traffic mainly to ATM or IP transport services.

Point of presence (PoP) at back-bone/transport services level; PoP systems are the kernel of the new public transport nets, and can be considered the logical evolution of the “traditional” Central Office (CO) and Digital Access Cross-connect Switches (DACS); they manage very high transmission speeds, including functions of an ATM switch and edge router, a terabit IP router, a remote access server, VoIP gateways, add-drop and DWM multiplexers. As switches read packet and cell headers, PoPs refer to a directory that indicates what sort of treatment should be given. Depending on the type of services the customer has purchased, this could include prioritisation, compression and encryption.

Remote access servers (RASs): There are "monster" RASs capable of terminating thousands of analogue calls from analogue modems, and "broadband" RASs that do the same thing for DSL.

VoIP (Voice over IP) gateways, which terminate circuit-switched voice calls.

It is worth noting that no TDMs are deployed on the new infrastructure, although they will continue to exist on the old public net. Although the access technologies on the old public nets can be linked to the new public net, the opposite is not normally the case.

Transport networks are usually built over optical fibres, with the need for flexibility in terms of new services solved by inserting specialised modules or systems in the network (Service Control Point, or SCPs).

According to Sprint's Integrated On-demand Network (ION), the new logic is lowering costs for carriers and corporate networks: in comparison with its TDM infrastructure, equipment should be 70% cheaper; access lines 60-80% cheaper; maintenance 50% cheaper; and provisioning 72% cheaper.

4.4. WAN evolutions

The trends confirm the evolution outlined in previous EITO reports: the widespread adoption of IP and faster speeds, with significant changes in terms of the net units and the way they can be managed. There are no significant changes in comparison with the trends of last year.

The main innovations concern the internal architecture of a node, greater scalability, compatibility with other switches, protocols and nets (IPX, SNA, ATM, Frame Relay, X.25, FDDI, Ethernet, Token Ring, Fast Ethernet, Gigabit Ethernet), the use of high-performance ASIC dedicated to specific processes, very high speeds per port (up to OC-12 at 622 Mbps), new routing methods such as the Routing Information Protocol (RIP), the Netware Link State Protocol (NLSP), Open Shortest Path First (OSPF) and the Border Gateway Protocol (BGP), advanced management functions and remote monitoring (RMON), and finally multicasting.

Network management is one of the most innovative areas for product/system development. The main applications relate to network availability and reliability, the automatic management of redundant paths without any service interruptions, dynamic reconfiguration, etc. The control of network intelligence is becoming an increasingly important strategic element for responding to the growing demand for flexible, advanced and customised services.

Together with the traditional voice circuit switching networks, Integrated-Services Digital Network (ISDN), Frame Relay (FR) and Asynchronous Transfer Mode (ATM) are the dominant technologies, and the dominance of the Internet is now requiring IP compatibility.

Section 4.3. describes the profound changes taking place in public nets, which also have a direct impact on WANs.

The use of ISDN is growing, particularly for connecting to the Internet at faster speeds than those attainable with conventional voice-line modems and for backing up critical communication paths; additional non-technical reasons include costs, its wider availability and the fact that it is now easier to order and obtain the required service to/from the provider.

For home and small-business users, ISDN provides a real data-transmission rate of 128 kb/s. Service providers specify a call set-up time of around 2-4 seconds, and usually get the job done in a matter of milliseconds. On the contrary, the fastest voice-channel modems on the market (the 56k units: see also V.90 in 4.6.3.)

rarely achieve their rated speed: the maximum is typically about 40-44 Kbps and it can take minutes to complete handshaking and set up a call.

From the service providers' point of view, both ISDN and ADSL are preferable to any voice channel modem because they allow users to stay connected to the Internet without nailing up expensive switched lines. ADSL separates Internet from voice traffic, and routes it around the switches. Thanks to a new technology called Always On/Dynamic ISDN (AO/DI), ISDN users can also reduce the load on switched circuits by staying connected using the shared 16-kb/s D channel and establishing a hard connection using one or both 64-kb/s B channels only when the bandwidth is really needed.

FR networks are increasingly replacing X.25 networks, and also gaining some of the advanced features previously considered to be exclusive to ATM: high speeds, such as T1/E1 (1.5-2 Mbps) and T3/E3 (44.736/34.368 Mbps; IP over FR; guaranteed bandwidths using the Committed Information Rate (CIR), flow control management and Quality of Service (QoS) levels; the fragmentation of the FR into smaller frames; and finally voice services.

The evolution of ATM mainly concerns its integration with IP and (as pointed out in the previous EITO report) multicasting, Multiprotocol over ATM (MPOA) for scalable internetworking and integration with existing Ethernet, Token Ring and TCP/IP infrastructures, Circuit Emulation Service (CES) for emulating T1/E1 and T3/E3 circuits, LAN Emulation (LANE), and Resource reSerVation Protocol (RSVP) for QoS.

The design and deployment of WANs are now mainly based on Virtual Private Networks (VPNs) in order to customise and integrate with the best functional and cost results.

4.4.1. Virtual Private Networks (VPNs)

The network infrastructure is already (or will soon be) a commodity as a result of the growing deployment of VPNs. The basic concept underlying VPNs is the use of the Internet instead of leased lines, with the creation of something like a "closed user group" providing a set of cheaper and customised services. Security and performance are the key areas of innovation as a result of the standardisation of specific protocols. The new VPNs will be supported by the new public networks which, based on connectionless IP, will run over managed backbones with guaranteed throughput and latency for different types of traffic. Some carriers will be able to add services on the fly and make sure their corporate customers get billed only for the applications and bandwidths they actually use.

WAN connections are intranet and extranet links. Intranets connect trusted locations and users within the same organisation (e.g. headquarters and branch offices), and the VPN should provide the same access to the corporate net for customers, providers, public administrations, etc. The security policy enforced by an intranet VPN is usually the standard corporate policy.

VPN devices can be hardware or software but, in both cases, their key characteristics refer to security and management functions. All of the products also handle dial-up as well as LAN-to-LAN connections. VPN boxes mix different functions: some also operate as IP routers, some serve as firewalls, and others offer certificated authorities. All provide strong authentication and modern cryptography (see 6.1.), and almost all are IP Security (IPSec) compliant.

The specific standards now (or soon to be) used for VPN are IPSec, the Point to Point Tunnelling Protocol (PPTP) Layer 2 Forwarding (L2F) and the Layer 2 Tunnelling Protocol (L2TP).

Table 3
A comparison of Ethernet topologies

	Ethernet 10BASE-T	Fast Ethernet 100BASE-T	Gigabit Ethernet* 1000BASE-X
Data rate	10 Mbps	100 Mbps	1000 Base Mbps (1 gigabit per second)
Cat 5 UTP	100 m (min)	100 m	100 m
STP/coax	500 m	100 m	25 m
Multimode fibre	2 km	412 m (hd)**, 2 km (fd)*	550 m
Single-mode fibre	25 km	20 km	5 km

* IEEE spec full duplex
** IEEE spec half duplex

IPSec has been designed to link LANs across the Internet via encrypted data streams. It defines two types of key management: an umbrella standard called Internet Key Exchange (IKE, formerly known as ISAKMP/Oakley) and a key exchange method called the Simple Key Exchange Internet Protocol (SKIP); and sets out two methods of secure transmission: encapsulating security payload (ESP) and authentication header (AH). ESP defines a method of tunnelling (the process of encrypting an entire packet and placing it inside a larger packet for transport), whereas AH defines a way of authenticating but not encrypting traffic. Although tunnelling involves more overheads, the encryption makes it a much safer way to move traffic.

PPTP is an alternative to IPSec based on the use of PPTP servers for connecting users to a VPN. PPTP establishes a secure tunnel between the client and the server by encapsulating encrypted messages inside TCP/IP packets. At the moment, it is mainly used for Windows environments.

L2F, proposed and developed by Cisco, makes it possible to encapsulate different protocols inside TCP/IP packets, but requires a specific L2F-compliant router.

L2TP, which has already been approved by the IETF, combines the best of L2F and PPTP; it offers support for multiple protocols and can be used over non-IP networks.

4.5. LAN evolutions

Ethernet logic dominates the LAN environment, and the evolution is more in the areas of Fast Ethernet (100 Mb/s) and Gigabit Ethernet (1 Gbps) than in any of the others, from Token Ring to Fibre Distributed Data Interface (FDDI) and ATM. From a technological point of view, emerging areas include Wireless LAN (considered in 4.7.) and the Home Area LAN based on power lines. An interesting research area, which is also strictly related to the wearable computer, deals with Personal Area Networks (PANs) and is briefly described in 4.5.3.

Ethernet networks are switch divided into segments that are small enough to prevent collisions between nodes from becoming a problem, with the segments communicating with one another over dedicated (not shared) paths through the switch. The result is that each client station gets a real 3-4-Mb/s connection, which is all that most of them really need. The Fast Ethernet and Gigabit Ethernet lines seldom serve individual client stations, but are used to connect switches to each other and to servers.

All Ethernet topologies have segment length limitations. *Table 3* compares the distance restrictions for current Ethernet topologies and Gigabit Ethernet.

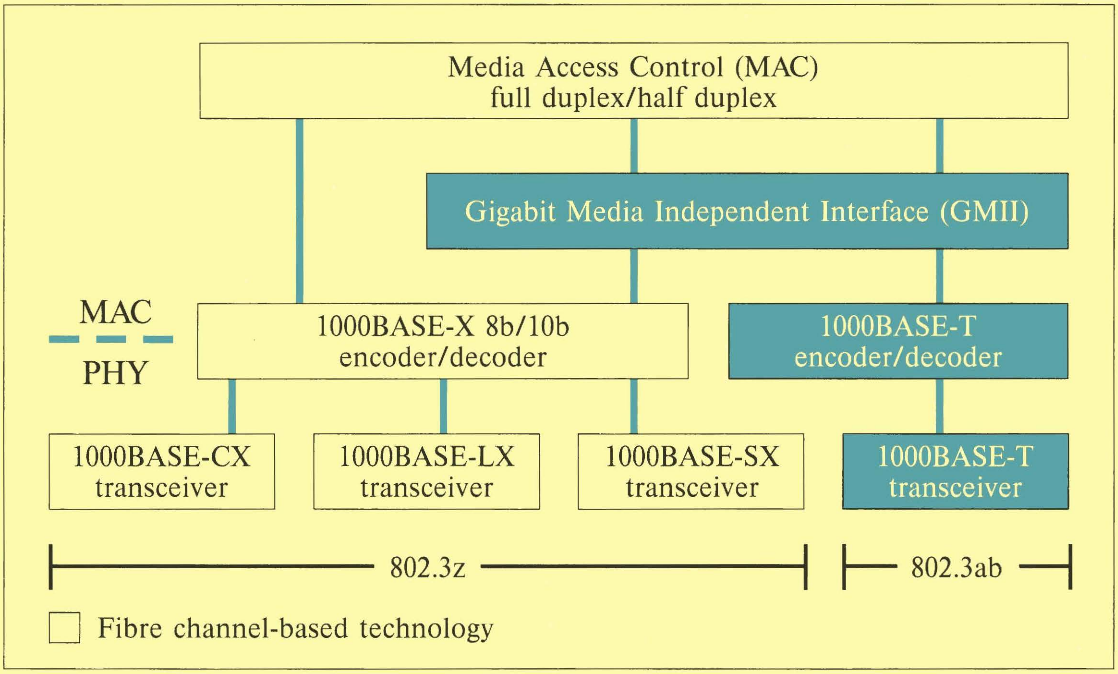


Figure 11
Gigabit Ethernet layers

Source: GigaEthernet Alliance

4.5.1. Gigabit Ethernet

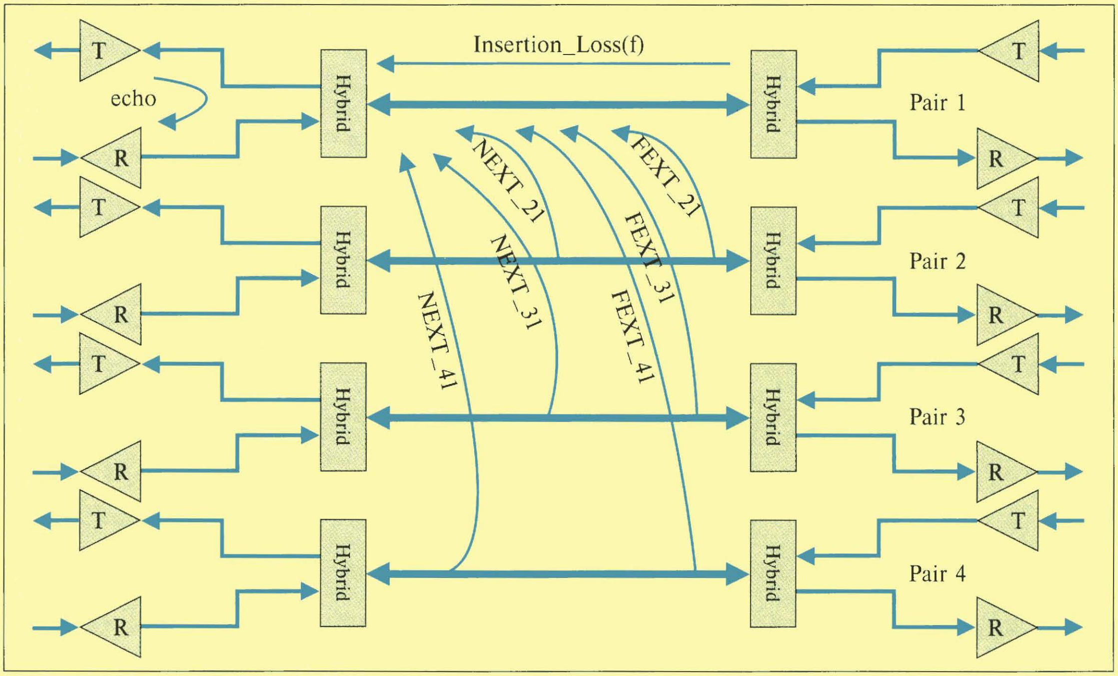
Fast Ethernet (or 100BASE-T) has become the leading choice among high-speed LAN technologies [http://www.gigabit-ethernet.com]. The growing use of 100BASE-T connections to servers and desktops is creating the need for higher-speed connections, particularly at backbone and server levels. Gigabit Ethernet should satisfy this need by allowing a smooth upgrade path that is cost effective and does not require further retraining because it uses the same Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol, the same frame format and the same frame size as its Ethernet predecessors.

The IEEE 802.3z Gigabit Ethernet Task Force defined the standard specification using the same IEEE 802.3 frame format, the CSMA/CD access method with support for one repeater per collision domain, thus allowing half- and full-duplex operation and flow control methods at 1000 Mbps, and assuring backward compatibility with the installed base of 10 Mbps and 100 Mbps Ethernet nodes. As shown in *Figure 11,* this task force identified three specific objectives for link distances: a multimode fibre-optic link with a maximum length of 550 meters; a single-mode fibre-optic link with a maximum length of 3 kilometers (later extended to 5 kilometers); and a copper-based link with a maximum length of at least 25 meters.

The 802.3ab task force, which was created in the Spring of 1997, is working to standardise a Gigabit Ethernet link with a maximum length of 100 meters on four pairs of Category 5 UTP cables.

1000BASE-SX (short wavelength fibre) is targeted at lowest cost multimode fibre runs in horizontal and shorter backbone applications, whereas 1000BASE-LX (long wavelength fibre) is targeted at longer multimode building fibre and single-mode campus backbones. In the case

Figure 12
The cabling challenge



Source: GigaEthernet Alliance

of multimode fibres, these standards define gigabit transmission over maximum distances of 220-550 meters; single-mode fibres, which are covered by the long-wavelength standard, are defined to cover distances of 5 kilometers.

1000BASE-CX (short run copper) is aimed at interconnecting equipment clusters in which the physical interface is short-haul copper. It is intended for use in horizontal copper cabling applications, and supports a switching closet or computer room as a short jumper interconnection for 25 meters distances. This standard uses the Fibre Channel-based 8B/10B coding at a serial line rate of 1.25 Gbps, and runs over 150-ohm balanced and shielded specialty cabling assemblies.

1000BASE-T is intended for "long-haul copper" interfaces based on four pairs of 100 ohm Category 5 cables at 100-meter distances or networks with a diameter of 200 meters (Category 5 link lengths are limited to 100 meters by the ANSI/TIA/EIA-568-A cabling standard). 1000BASE-T uses the same auto-negotiation system as 100BASE-TX, thus simplifying the task of gradually integrating it into legacy Ethernet networks. Furthermore, many of the companies working on 1000BASE-T have indicated they will produce dual-speed PHYs capable of both 100 Mb/s and 1000 Mb/s operations. This ensures that 1000BASE-T devices can "fall back" to 100BASE-TX operation and thus provides a flexible method for upgrading systems. As *Figure 11.* shows, 1000BASE-T does not use the Fibre Channel 8B/10B encoding scheme.

Transmitting a 1000 Mb/s data stream over four pairs of Category 5 twisted-pair cables presents a number of design challenges due to signal attenuation, echo, return loss and crosstalk characteristics of cables, as well as electromagnetic emissions and susceptibility *(Figure 12)*.

Many of these principles and techniques have already been used in three 100BASE-T (Fast Ethernet) copper physical layer solutions.

Gigabit Ethernet uses the same variable-length (64- to 1,514-byte packets) IEEE 802.3 frame format as that used in Ethernet and Fast Ethernet, something that allows complete interoperability between all of the existing Ethernet types.

Other high-speed technologies use different frame formats, and so the switch or router must translate each Ethernet frame to the other formats and vice versa.

Gigabit Ethernet provides full- and half-duplex operation. Two nodes connected via a full-duplex switched path can simultaneously send and receive packets. Almost all of the Gigabit Ethernet products on the market in 1998 were full duplex.

When operating in half-duplex mode, Gigabit Ethernet adopts the same fundamental CSMA/CD access method in order to resolve contention for the shared media. The Gigabit Ethernet CSMA/CD method was enhanced in order to maintain a 200-meter collision diameter at gigabit speeds. Without this enhancement, minimum-sized Ethernet packets could complete transmission before the transmitting station sensed a collision, thereby violating the CSMA/CD method.

To resolve this issue, both the minimum CSMA/CD carrier time and the Ethernet slot time have been extended from their present value of 64 bytes to a new value of 512 bytes (the minimum packet length of 64 bytes has not been affected). Packets with fewer than 512 bytes have been augmented by means of a new carrier extension field following the CRC field, whereas those that are longer than 512 bytes have not been extended. These changes, which may affect small-packet performance, have been offset by incorporating a new "packet bursting" feature into the CSMA/CD algorithm, which will allow servers, switches and other devices to send bursts of small packets in order to make full use of the available bandwidth.

Gigabit Ethernet uses the same management objects as those used by Ethernet and Fast Ethernet, and the same Management Information Base (MIB) and Remote Monitoring (RMON) agents can be used to provide network management. By means of the Simple Network Management Protocol (SNMP), the information collected at device-level is structured according to MIB in order to record key statistics, such as collision counts, the number of packets transmitted or received, error rates and so on. Additional information is collected by RMON agents in order to aggregate the statistics for presentation via a network management application.

Gigabit Ethernet provides high-speed connectivity, but does not itself provide a full set of services such as Quality of Service (QoS), automatic redundant fail-over, or higher-level routing services; these are added via other open standards at higher levels, such as RSVP at the network layer (that provides bandwidth reservation), and IEEE 802.1Q and 802.1p, which provide virtual LAN (VLAN) and explicit priority information for packets in the network (see also EITO 97 and EITO 98).

4.5.2. Home Local Area Networks (LAN)

The EITO 98 paper "ICT for European homes: devices, services and applications" described the way in which almost all of our domestic appliances (electronic and not) can be remotely monitored and controlled: not only lighting, but also a PC, HiFi, TV, VCR, answering machines, central heating and air conditioning, dishwashers and washing machines, and security and safety alarm systems. These controllers and automation modules may be based on wired (including mains electricity) or wireless connections that are provided by radio and/or infrared technologies.

However, despite the fact that all of these devices are becoming increasingly smart and can sometimes already interoperate, they are generally based on proprietary solutions that limit the types and functions of the devices that can be interconnected, and lead to the need for an overwhelming number of different cables. The concept of a "home" LAN is a natural response to this situation and also represents a major step towards what can be called a real "digital home".

As the use of traditional LANs such as Ethernet is considered complex, expensive and only suitable for PC-based equipment, a new approach has been proposed by ETSI based on the IEEE 1394 high-speed bus called Home Local Network (HLN: see also section 3.2.3.). This is a standard designed to have multiple connectors that allow daisy-chain and tree topologies, and up to 64 devices attached to each bus segment. The IEEE 1394 is easy to use, inexpensive, scalable and flexible: it allows real "plug and play", and a device can be added or removed even when the bus is in full operation.

Another approach is based on the use of domestic power lines, as has long been the case for proprietary solutions such as X-10 [http://www.x10.com], and it now seems that it could also be possible via the High-Frequency Conditioned Power Network (HFCPN), the technology originally introduced for TLC local accesses through the electricity network (see 4.6.4.). No standards for this approach are likely to be developed in the short term.

4.5.3. Personal Area Network (PAN)

MIT's Media Lab [http://www.mit.edu] and IBM's Almaden Research Center [http://www.research.ibm.com/] have developed the Personal Area Network (PAN), which is designed to pass digital information between an individual and a device (or between two individuals) via a simple touch. A prototype PAN system allows users to exchange electronic business cards by shaking hands.

The digital data transmission is provided by a tiny electrical field, with the signal conducted by the natural salinity of the body. The current is one-billionth of an amp, which is less than the natural currents already in the body. The use of a low-frequency carrier (less than 1 MHz) means that no energy is propagated, and thus minimises remote eavesdropping and interference by neighbouring PANs. The data transmission speed of the prototype is equivalent to a 2,400-baud modem and can theoretically reach 400,000 bps.

PAN technology is a form of near-field communication that constitutes a meaningful alternative to other technologies such as infrared and radio communications. Focused infrared (commonly used in TV remote control devices) is based on line-of-sight transmission, which is difficult to maintain with body-based devices that are constantly in motion, and diffused infrared is based on a wide-angle beam of high optical power that requires a large power capacity. Finally, even low-powered radio communications lead to eavesdropping and interferences; furthermore, the radium spectrum is very crowded and governed by complex regulatory controls that vary from country to country

Figure 13 shows the logic schema of a PAN: the credit card-sized transmitter and receiver are battery powered, electrically isolated, and have a pair of electrodes. The transmitter capacitively couples a modulating picoamp displacement current through the human body to the receiver. The return path is provided by the "earth ground" that includes all of the environmental conductors and dielectrics in close proximity to the PAN devices. The earth ground needs to be electrically isolated from the body in order to prevent shorting the communication circuit.

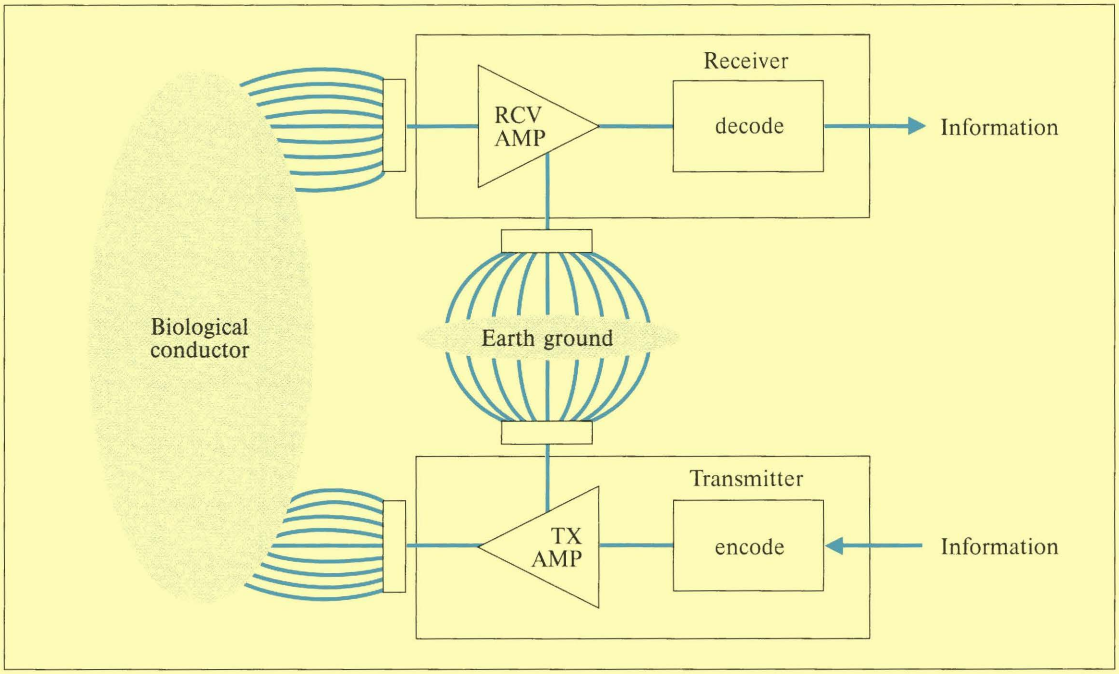


Figure 13
The conceptual PAN scheme

Source: IBM Research

PAN devices can be thought of as wearable computer components, such as watches, credit cards, spectacles, identification badges, belts, waist packs and shoe inserts.

PAN prototypes are already in operation, and the possible initial applications represent a major step towards cyberlife and natural computing: the exchange of information between a user and his/her ICT devices (personal digital assistants - PDAs, pagers, cellular phones and smart cards); the exchange of information between persons, such as electronic business cards exchanged during a handshake; the automation of secure business transactions, such as user authentication for automatic telling machines, patient identification in the health services; and so on.

4.6. The evolution of customer access

The rapid increase in the speed and capabilities of WANs and backbone nets requires a parallel increase in local access speed and capacity by end-users. Customer access has so far been provided via modem by traditional POTS (Plain Old Telephone Service), which allows speeds normally in the range of 2.4-28.4 Kbps and recently also of 56 Kbps with high-speed modems such as X2 and K56flex, which are now standardised by the V.90 recommendation (see 4.6.3.).

In order to support interactive multimedia, local access has to provide faster facilities that are also cheaper than dedicated (normally up to T1/E1), or ISDN and FR lines. Other access technologies include xDLS, CATV cabling via broadband modems and wireless connections (see 4.7.), and finally the use of power distribution lines also for data transmission (as discussed in 4.6.4.).

The technological trends are mainly focused on squeezing the best possible performance from the existing infrastructures, twisted pairs, coax cables, mobile and satellite systems, while reducing end-user access costs.

4.6.1. Digital Subscriber Loops (xDSL)

xDSL is a set of megabit bandwidth technologies based on the standard unshielded twisted pairs (UTP) traditionally used for phone cable, without amplifiers or repeaters along the copper route: xDSL can deliver voice, TV images and on-line interactive information.

"Basic" DSLs carry both a 4-kHz analogue signal for audio (the traditional POTS) and a digital signal for data, and run from a telephone company's central office (CO) into a customer's building, where they are connected to one or more telephones, fax machines or modems.

xDSL is a modem-like technology that requires suitable xDSL equipment at each end of the twisted pair in order to modulate-demodulate the digital data stream into a high-speed analogue signal. The modulating techniques used for xDSL are 2B1Q, carrier-less amplitude phase modulation (CAP) and discrete multitone modulation (DMT).

2B1Q is a straightforward signal type that has 2 bits per baud arranged as one quaternary (i.e. a four-level pulse amplitude modulated scheme), and used for HDSL, S-HDSL, and ISDN BRI. It transmits data at twice the frequency of the signal.

DMT is a newer multicarrier technology that divides the three channels into 256 sub-channels onto which traffic is overlaid, thus adding a layer of multiplexing to the data stream. It has the benefit of being able to distinguish and isolate sub-channels of inferior quality or with too much interference and to divert the traffic to neighbouring sub-channels. This is a robust approach that leads to high quality and reliability. DMT is the official ANSI standard for ADSL and offers 6 Mbps downstream and 640 kbps upstream.

CAP is a relatively cheap proprietary digital modulation technique based on a mature technology that offers 1.5 Mbps downstream with only 64 kbps upstream.

Table 4 compares xDSL technologies that provide different maximum speeds for upstream and downstream transmissions: in comparison with the similar table included in the last EITO report, there is a new entry that involves a variant of ADSL known as DSL-Lite or G.lite.

In comparison with ADSL, DSL-Lite eliminates the need for a POTS splitter in both the remote terminal and the central office. Splitters are designed to separate the voice band from the DSL spectrum in order to prevent the signals from interfering with each other. In the case of CSA loops, payload data rates of over 1.5 Mbps downstream and over 384 Kbps upstream can be supported; for longer loops, the system achieves payload rates of over 512 Kbps downstream and 128 Kbps upstream; for those requiring symmetrical rates, DSL-Lite can support 384 Kbps over the 18,000 foot loops. All of these data rates are simultaneously supported with voice band services such as POTS, fax, and modems. The ITU's G.992.2 specifications, which are expected to be ratified in June 1999, will provide the basis for interoperable modem products that support data rates of up to 1.5 Mbps downstream and 512 Kbytes upstream, while eliminating the need for telephone companies to install splitter equipment or special wiring on customer premises. Previously known as G.lite, the specifications are also being promoted by a consortium of leading computer and telecommunications suppliers known as the Universal ADSL Working Group (UAWG) [http://www.uawg.org].

Table 4
xDSL comparison

DSL technique	Distance	Upstream transmission rate	Downstream transmission rate
IDSL, ISDN Digital Subscriber Line	12,000-18,000 feet	128 Kbps	128 Kbps
HDSL, High Data rate Digital Subscriber Line	up to 12,000 feet	- 768 Kbps - 1.544 Mbps with 2 twisted-pair lines - 2.048 Mbps with 3 twisted-pair lines	- 768 Kbps - 1.544 Mbps with 2 twisted-pair lines - 2.048 Mbps with 3 twisted-pair lines
SDSL, Single line Digital Subscriber Line	up to 10,000 feet		- 1.544 Mbps with 1 line - 2.048 Mbps with 1 line
ADSL, Asymmetric Digital Subscriber Line	downstream is affected by distance: from 9,000 up to 18,000 feet for decreasing speed	from 16 to 640 Kbps	from 1.5 to 9 Mbps
DSL-Lite (G.lite)	Up to 24,000 feet	from 128 to 384 Kbps	from 384 Kbps to 1.5 Mbps
CDSL, Consumer DSL	12,000-18,000 feet	128 Kbps	1 Mbps
RADSL, Rate-Adaptive Digital Subscriber Line	12,000-18,000 feet	from 128 Kbps to 1 Mbps	from 600 Kbps to 7 Mbps
VDSL, Very high data rate Digital Subscriber Line	from 1,000 up to 4,500 feet for decreasing speed	from 1.5 to 2.3 Mbps	from 13 to 52 Mbps

The significance of DSL-Lite technology, which is DMT-based, is that it has been designed for easy, low-cost deployment and avoids the need for a voice-data splitter at every user site. The elimination of the voice-data splitter solves the major deployment bottleneck of the telephone company truck-roll, and this technology will enable an integrated PC modem solution for high-speed Internet access over existing phone lines.

Consumer DSL (CDSL) has been recently proposed for simultaneous voice call and Internet access over a single phone line.

4.6.2. Cable modems

Cable modems provide secure, high-performance, asymmetric connectivity. They use the existing TV cabling and are capable of data rates that are nearly 1000 times faster than traditional telephone modems. A typical broadband modem features a 30 Mbps downstream data rate and a 2.56 Mbps upstream rate. However, as most cable is unidirectional (designed to carry video signals from the cable company to a subscriber's residence), a large percentage of installed cable provides only downstream transfer. Cable transmission requires an inverted tree topology: a large trunk carries the signal from the cable company, and is then divided into branches (i.e. cables) and subbranches until reaching the subscribers' homes. All of the users on a branch share the cable's bandwidth.

The IEEE 802.14 Working Group recently ended its mission to create standards for data transport over traditional cable TV networks. It specifies a hybrid fibre/coax plant with an 80 kilometer radius from the head end, that transports IEEE 802.2 LLC traffic types and, in the near future, will also use ATM cells for different types of multimedia traffic. The use of Hybrid Fibre Coaxial (HFC) is spreading rapidly in CATV networks because a fibre provides large bandwidth and thus enables the development of new services other than television broadcasting: video-on-demand, interactive computer games and video telephony.

IEEE 802.14 defines a physical (PHY) and a Medium Access Control (MAC) layer protocol for HFC networks.

Other standard bodies, such as the ATM Forum Residential Broadband (RBB) Working Group [http://www.atmforum.com], the Digital Audio Visual Council (DAVIC) [http://www.davic.org], the Society of Cable Telecommunication Engineering (SCTE) [http://www.scte.org] and the IEEE 802.14 Cable TV Working Group [http://www.ieee.org] are also reviewing standards for cable modem technology.

4.6.3. V.90 modem

As pointed out in last year's report, the most advanced modems have a speed of as much as 56 Kbps, which can only be reached for downstream transmissions (from the Net to the PC); the maximum in the opposite direction is 33.6 Kbps. Furthermore, the connection requires a digital line at least up to the final switch before the subscriber's loop towards the address of the end-user, because it is this that reduces the number of analogue/digital conversions to only two (the modem on the one hand, and the last switch of the carrier on the other) and thus increases the overall quality of the connection.

Modem manufacturers originally adopted two different approaches: X2 developed by US Robotics [http://www.usr.com] and K56flex developed by Lucent [http://www.lucent.com] and Rockwell Semiconductor System Inc. [http://www.bn.rockwell.com]. But now the new ITU V.90 standard has established a compromise solution establishing that central site equipment will release a new code allowing ISP ports to be ITU V.90 compatible. As soon as the ISP deploy the V.90 code at their POPs, the users that get flash upgrades allowing their X2 or K56flex modems to run V.90 can rest assured that both will work.

It is likely that the V.90 modem standard will become the final analogue modem speed standard and represent a common access to the Internet for the majority of users. This is particularly true in the case of those who cannot use other high bandwidth technologies (e.g. cable modems and DSL), because many and particularly rural countries will not have installed the necessary infrastructures.

4.6.4. The electricity network for local TLC access (HFCPN)

Some electricity companies use the electricity distribution network as a means of delivering both power and TLC services to the home. "Last mile" distribution networks are normally based on pseudo-coaxial cables and the use of suitable "conditioning units" makes it possible for them to carry simultaneously two or more electrical signals extending from ultra-low (50-60 Hz) to ultra-high frequencies (500-600 MHz) without any mutual impairment. An example of such a High-Frequency Conditioned Power Network (HFCPN) is given in *Figures 14* and *15*, in which the conditioning unit (CU) provides an electricity distribution port (EDP) at 50-60 Hz and a communication distribution port (CDP) at more than 1 MHz.

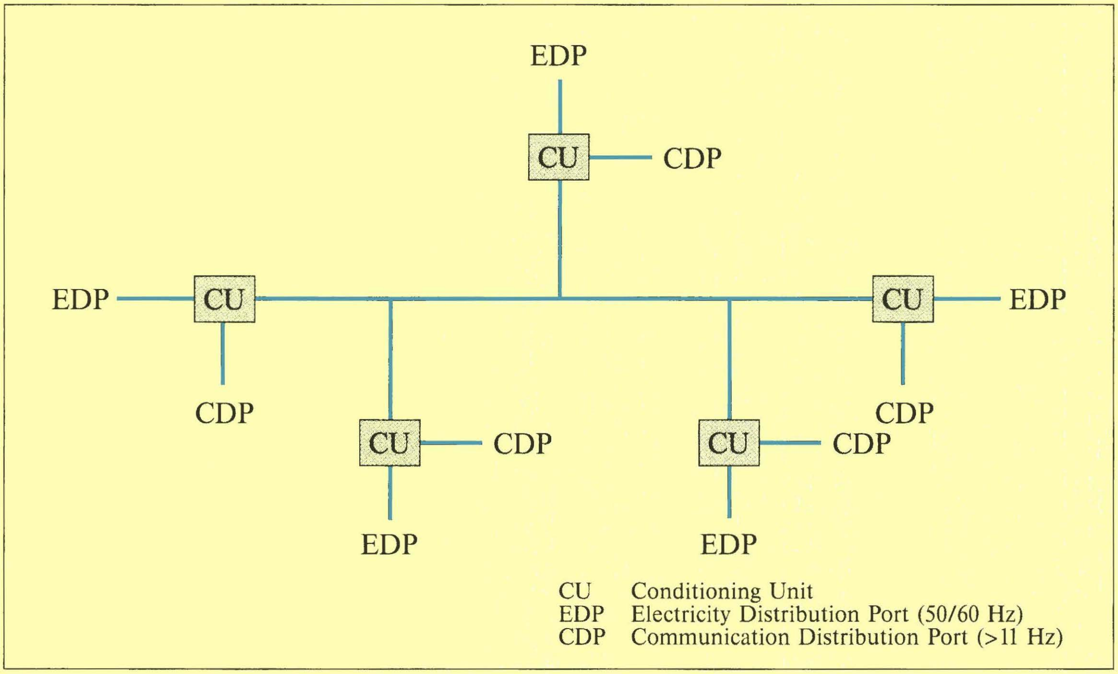


Figure 14
The HFCPN layout

Source: Nortel

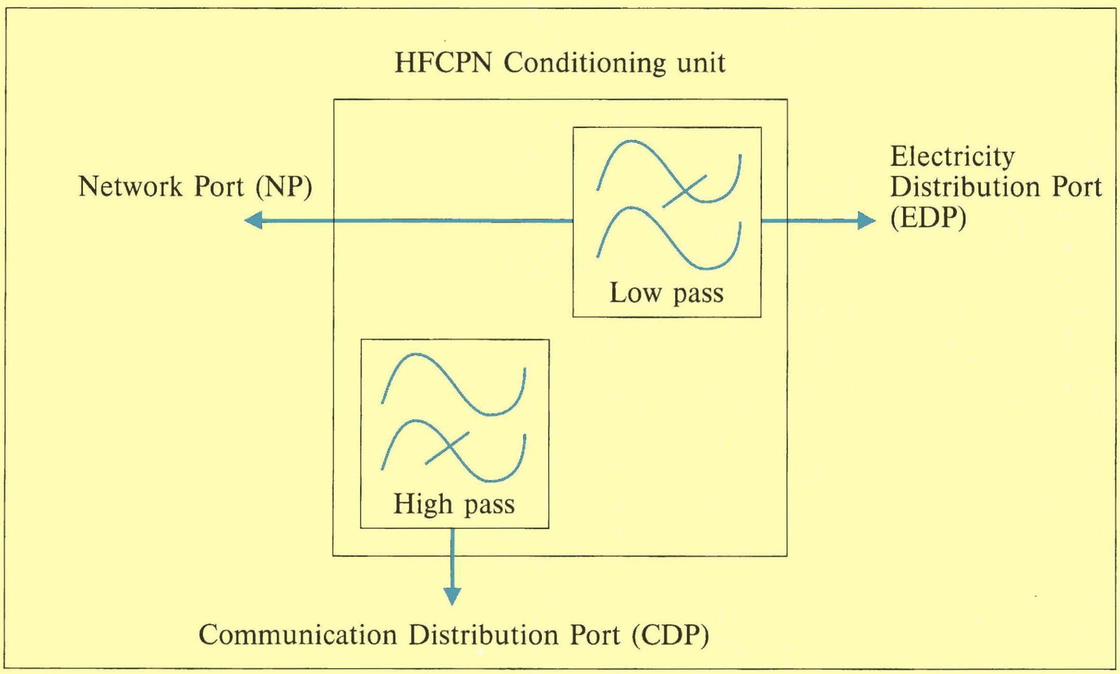


Figure 15
HFCPN conditioning units

Source: Nortel

The basic technical characteristics of a CU include:

- the safe and efficient interconnection of signals of >1 MHz;
- the directional propagation of signals of >1 MHz;
- a minimum noise floor of more than 1 MHz;
- the isolation of variable customer loads of >1 MHz;
- suitable network service termination points for electricity and telecommunication services;
- optimum cable network spectral performance.

The deployment of HFCPN for local access depends on the number of users (typically 50), whether the access is dedicated or switched, the type of information (voice, data, still or moving pictures), the use of digital or analogue transmission, coding and modulation techniques, the level of traffic, etc.

When the transmission technology of telephony standard No. 2 (CT2) is used, HFCPN can provide 32 Kbps multiple and digital access to customer premises, but this local access network has to be connected to a broadband WAN if it is intended to provide multimedia digital services.

4.7. Wireless and mobile communications

Mobile communication is one of the key directions of the ICT evolution: wireless and satellite systems are increasing their capacity and performances, in particular for high speeds and the support of multimedia information, and are also reducing their dimensions. The new systems are all based on digital signals. The trends foreseen in the previous EITO editions occurred with continuous improvements, but no paradigm shift has occurred. One of the key factors is the growing integration and the interoperability between fixed and mobile environments.

Wireless technologies are deployed both in the last mile area and in global, worldwide, networks: LMDS (local multipoint distribution service), and WLAN (wireless LAN), are good examples of wireless customer access, and satellite systems, as Iridium, and the future UMTS, are examples of technologies for universal networks.

Table 5 illustrates the heterogeneous nature of the currently used wireless technologies: i.e. GSM mainly in Europe and now also in Asia; CDMA in the USA.

Third-generation systems should support high-speed data and multimedia applications of up to 144 kb/s while moving any distance, and up to 2 Mb/s wireless access in a local area. Furthermore, they are designed to give users consistent voice, data, graphic, multimedia and video-based information and communication services, regardless of their network location (cordless, cellular, satellite, fixed wire line, etc.).

The third-generation mobile telephone system in Europe is known as the Universal Mobile Telecommunication System (UMTS), and has been standardised by the ETSI. The ITU is currently formulating its International Mobile Telecommunications 2000 family of systems (IMT2000) that will let users roam throughout the world using the same handset that will include UMTS as a subset.

Most of the work done so far has concentrated on the wireless part. Third-generation UMTS services are expected to be introduced in Japan by 2001 and in Europe by the year 2002.

Table 6 shows the key characteristics of the three generations of mobile telephony.

The new wireless wideband systems will offer both real-time (e.g. for speech) and non real-time modes (e.g. for e-mail) using common mechanisms capable of providing reliable transport for message, file and stream-type data.

Table 5
Wireless technology

Technology	Cell dimension	Delay (< 10 msec)	Wireless loop	Coverage
TDMA IS-136A, Time-Division Multiple Access	macro	no	no	country, sub-urban, urban
CDMA IS-95A, Code Division Multiple Access	macro	no	no	country, sub-urban, urban
GSM, European Global System for Mobile Communications	macro	no	no	country, sub-urban, urban
PACS, Personal Access Communications System	macro	yes	yes	sub-urban, urban
W-CDMA, Wide-band Code Division Multiple Access	macro	no	possible	country, sub-urban, urban
AMPS/NAMPS Advanced Mobile Phone System	macro	yes	no	country, sub-urban, urban
DECT, Digital Enhanced Cordless Telecommunications	pico	no	yes	urban
PHS, Personal Handphone System	pico	no	yes	urban
Satellite	jumbo	high delay	no	global

Source: SMAU ICT Observatory 1998

Table 6
The different generations of mobile phones

	Time frame	Operating frequency	Technique	Standards
First generation	1979–	450 MHz 900 MHz	analogue	AMPS, Advanced Mobile Phone System NMT, Nordic Mobile Telephone TACS, Total Access Communications System
Second generation	1990–	900 MHz 1800 MHz 1900 MHz	digital	GSM, European Global System for Mobile Communications TDMA, Time-Division Multiple Access CDMA, Code Division Multiple Access
Third generation	2002–	2000 MHz	digital	IMT2000 (CDMA) UMTS

The virtual home environment (VHE) is a new customer option that allows customers to personalise their services anywhere and use them at any time in both wireless and wired environments. Third-generation systems will also allow users to determine at call set-up the quality of the voice or video call, and pay accordingly. The future UMTS network must support different access mediums that range from wireless local loops to cellular and corporate wireless local-area networks (WLANs).

The UMTS system is based on a layered approach: in small localised areas (picocells) such as offices or homes, the available radio access bandwidth is up to 2 Mb/s. The picocells are covered by a larger microcell that offers a lower bandwidth of 384 kb/s and can cover a few square kilometers. These picocells and microcells are covered by a larger macrocell that offers lower bandwidth services (144 kb/s) over a larger area (e.g. a city), and a global satellite system will cover remote areas.

The UMTS Forum [http://www.umts.org] has calculated that the total terrestrial spectrum demand in 2010 will be 580 MHz, with 240 MHz being defined as second-generation standards for Europe. Given that the Forum had previously concluded that the full 155 MHz for the terrestrial UMTS designated by the ITU should be made available, an additional 185 MHz is required. The calculated spectrum demand for the satellite component of the UMTS is 50 MHz by 2005 and 90 MHz by 2010.

There is a need to designate an additional 20 MHz as a start-up band for non-public non-licenced in-building low mobility systems. This spectrum will be required from the year 2002 in order to help build the market for multimedia terminals and stimulate a demand for public UMTS access. The UMTS frequency spectrum will be reserved for systems using UMTS as defined in the standards adopted by the ETSI.

4.7.1. Code Division Multiple Access (CDMA)

The emerging technologies towards the universal mobility are W-CDMA (Wideband-CDMA), the evolution of the CDMA for broadband and the TD/CDMA (Time Division-CDMA), that allows to lower the access speeds in comparison to W-CDMA. These two technologies have been proposed and are supported by different groups of manufacturers. Further pro and contra debates might be avoided by the recent ETSI decision to consider W-CDMA for large geographic areas and TD/CDMA for local areas, such as LAN, subscriber loops, etc.

The rising importance of CDMA is due not only to improve the service quality, but also to improve the transmission capacity.

Using time-division multiple access (TDMA) as the radio access (or "air interface") technology, operators of cellular systems like the GSM (European Global System for Mobile Communications) and the North American Digital Cellular system can squeeze three voice circuits into the bandwidth required by a single analogue circuit. With the more advanced code-division multiple access (CDMA) technology they can further improve the capacity. One of the success factors of GSM is its network specification, based on the signalling system No. 7 (SS7): in fact its mobile application part (MAP) includes procedures for coping with mobile users, making international roaming very easy for GSM users.

CDMA radio access technology will be included in GSM networks, along with TDMA.

The hand sets will be dual-mode units. They will use CDMA radio technology where it is available and will fall back to TDMA where it is not. Cellular TDMA systems assign time slots to individual calls.

All the communicating parties must maintain synchronisation: each hand set derives its clock from the base station. But since the distances from the mobile units to the base station are all different and changing, synchronising the clocks with a received reference signal is not enough. The base station must also determine how far away the mobile units are and must tell each of them when to transmit with respect to the reference. By implementing this advanced timing feature and thereby decreasing the uncertainty in the timing of individual slots, the GSM system reduces the guard time required around each slot from 230 μs to about 30 μs.

Instead of separating signals by time or frequency division, CDMA systems let them occupy the same bandwidth at one and the same time. But before the digital signals are commingled, each is processed by being exclusive-ORed (added module 2) to a (different) pseudorandom noise sequence. At the receiving end of each channel, the signals are recovered by again exclusive-ORing the demodulated signal with the same pseudorandom noise sequence used to encode it. The pseudorandom noise sequences are all mutually orthogonal, or nearly so, which means that after recovery, the shared traffic in the channel sounds like random noise, rather than annoying interference. As more users come to share a channel, the signal-to-noise ratio gradually degrades, which is why the capacity of a CDMA system is, to some extent, a matter of opinion; it depends on how sensitive the subscriber is to background noise.

To conclude, the capacity of a CDMA system is not a single constant number: it depends on the locations of the users as well as on their number, and it is also a function of how low a signal-to-noise ratio is deemed to be acceptable.

4.7.2. Wireless LAN (WLAN)

For several years some wireless LAN (WLAN) technologies have been implemented, but they are all proprietary solutions, and the lack of any standards compromised the diffusion of WLANs, even if their usages have become increasingly necessary. ALOHA, was one of the first LANs and the basis for Ethernet, and it was radio-based. The most common form of wireless communications today, modem-based over cellular connections, provides a transmission rate of only a few Kb/s. Infrared LANs, one of the alternative technologies, have also been limited by dramatic interference problems caused by sunlight and artificial light.

The recent definition of the new 802.11 wireless LAN standard for the 2.4 GHz range is removing all these barriers, and WLANs are going to be an actual complement to wired LANs in enterprise-wide solutions. The technology is now mature and cost-effective, and the cost for wireless LAN NICs (network interface cards) are rapidly dropping in comparison with wired Ethernet.

Today, two approaches are used to implement spread spectrum for WLAN transmissions, Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS). FHSS uses a large number of frequency channels, 80 with the transmitter sending a burst over one and then “hopping” to another channel. When two stations have to transmit at the same time, each picks a frequency and transmits for a specified time slot. At the end of that time slice, they both shift or hop to another frequency slot. The precise hop sequence must be known to both the sender and receiver of each channel. The typical bandwidth of the information signal is 1 MHz and the time slot interval is a tenth of a second. The 802.11 standard sequence specifies 79 slots, at least 75 hops and the dwell time must be no more than 400 milliseconds. The hop sequence is known by both the sender and receiver. Both the number of hops and the maximum “dwell” time are dictated by the regulatory agency in each country.

DSSS is an older technology that is now gradually been replaced by FHSS. It takes a baseband signal and replaces the message with calculated blocks of fixed length codes, spreading the bandwidth by a large factor. The receiver knows the decoding sequence and retrieves the original message. DSSS and FHSS are not interoperable, although some vendors provide such a function.

The IEEE 802.11 defines a cellular network. The area covered by a single WLAN is called the cell. The basic cell is called the BSS (Basic Service Set). Each BSS will contain many stations (STAs) with a head station called the Access Point (AP), which coordinates all communications inside and outside the cell, acts as a bridge into the wired LAN (WLAN normally operates with wired Ethernet) and synchronises all of the stations within the cell so that they perform the frequency "hopping" at the proper time and frequency. If the AP connects with another 802 network (such as an Ethernet), it is called a portal. The connecting 802 LAN is called a Distribution Service (DS). Collections of BSSs and DSs form a whole called an Extended Service System (ESS). The maximum number of stations within a cell depends on the data traffic: a typical upper limit is about 15 stations, a less-intensive environment might support up to 50. The cell diameter depends on many factors: a typical configuration is up to 200 meters inside buildings and about a kilometer in outside environments.

The 802.11 physical layer defines three specifications: Frequency Hopping (FH) Spread Spectrum, Direct Sequence (DS) Spread Spectrum and infrared (IR). The FHSS and DSSS are assumed to run at 1 or 2 Mb/s nominal.

The MAC layer defined by 802.11 uses as the Basic Access Method, the CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance), a variant of Ethernet's CSMA/CD (Collision Detection), in order to reduce the chances of collisions. The transmitting station first sends a very short packet called the Request to Send (RTS) which contains the source and destination station addresses plus an indication of the duration of the intended message. If the medium is free, the receiver will reply with a Clear-to-Send (CTS). On receipt of that, the sender station can start. If the medium is busy, the sender station waits and tries to send a RTS after an exponential backoff, analogously to the CSMA/CD.

In addition to the normal MAC layer functionality, the 802.11 MAC layer also provides for fragmentation, packet reassembly and acknowledgments.

4.8. Digital Video Broadcasting (DVB)

Digital Video Broadcasting (DVB) is a set of ETSI standards for digital broadcasting in Europe, provided mainly by the international industry DVB project. The DVB standards are based on the MPEG-2 audio and video compression tool-set, and can be used in a wide range of transmission media. The "Data Container" of a DVB system allows the broadcaster to allocate capacity to a variety of services depending on the requirements of the material and the tastes of the audience. Allocations can even be made dynamically, for instance by offering HDTV (High definition TV) services at one time of day and multiple channel SDTV (Standard TV) services at another.

MPEG-2 video specifications allow four source formats (or "Levels") to be coded, ranging from Limited Definition (about today's VCR quality) to full HDTV, each with a range of bit rates. In addition to this flexibility in source formats, MPEG-2 allows different profiles, each one which offers a collection of compression tools that together make up the coding system: a different Profile means that a different set of compression tools is available.

The ETSI document ETR 154 specifies the DVB guidelines for the implementation of the MPEG-2 system layer, video compression and audio compression for satellite, cable and terrestrial broadcasting applications. Revision 2 of this document has extended its scope to encompass HDTV and SDTV applications for both 25 Hz and 30 Hz video frame rates.

Whether for SDTV or HDTV, DVB bit streams must comply with the restrictions of MPEG-2, whose upper limits are listed in

Table 7
Bitstream upper limits

DVB bitstream upper limits	Lines per frame	Luminance samples per line	Luminance samples per second
STDV (MPEG-2: main profile at main level)	576	720	10,368,000
HDTV (MPEG-2: main profile at high level)	1,152	1,920	62,668,800
HDTV CIF (1,920 pixels per line)	1,080	1,920	

Table 7. The table also includes the parameters required by the Common Image Format (CIF), the single source format for both 25 Hz and 30 Hz frame recommended by the ITU and DAVIC and endorsed by DVB.

DVB comprises specifications for different media and transmission techniques:

- *Digital terrestrial broadcasting systems (DVB-T):* EN 300744 specifies the use of terrestrial transmission; TS 101191 defines a Mega-frame for SFN (single-frequency network) synchronisation and TR 101190 provides implementation guidelines for DVB terrestrial services.
- *Digital satellite transmission systems (DVB-S):* EN 300421 describes different tools for channel coding; TS 101198 specifies how to implement BPSK (Binary Phase Shift Keying) modulation in DVB satellite transmission systems; the frequency range is 11.7-12.5 GHz.
- *Digital cable delivery systems (DVB-C):* EN 300429 specifies channel coding and modulation for DVB signal delivery on cable systems (CATV).
- *(Satellite) Master Antenna TV (DVB-CS):* EN 300473 specifies the use of installations for (S)MATV.
- *Microwave data broadcasting:* Two specifications are defined for the Multi-channel Microwave Distribution System (MMDS), depending on the frequency range applied; EN 300748 describes MMDS for use at 10 GHz and above (DVB-MS) and EN 300749 the MMDS for use at frequencies of less than 10 GHz. This standard is based on cable (DVB-C) technology and has therefore been called DVB-MC.
- *Service information (DVB-SI):* This defines the navigational aids provided as part of the DVB streams and necessary for the IRD (Integrated Receiver Decoder) to be able to tune to such channels and for for the DVB customer to be able to navigate the profusion of programmes. EN 300468 constitutes this set of aids, ETR 211 defines the guidelines describing how the SI should or could be used, and ETR 162 lists SI codes indicate the services offered by different broadcasters.

DVB introduces the concept of "Conditional Access" in order to enable control over access to programmes, services, etc. that are not freely available. Conditional Access systems consist of several blocks, including the mechanism to scramble the programme or service, the "Subscriber Management System (SMS)" for storing all customer data, and the "Subscriber Authorisation System (SAS)" for en-/decrypting and delivering all of the codes necessary for descrambler functionality in order to make the programmes intelligible. For SMS and SAS, DVB specifies only the "Common Scrambling Algorithm" (ETR 289), a powerful tool that makes it possible to secure scrambling of

Transport Streams or Programme Elementary Streams. In order to descramble programmes in parallel broadcasts, DVB specifies a "Common Interface for Conditional Access and other Digital Video Broadcasting Decoder Applications" (EN 50221) that allows an IRD to manage different Conditional Access systems. The term "MultiCrypt" describes the simultaneous operation of several Conditional Access systems; the term "SimulCrypt" describes the capacity of viewers to use only one conditional access on their IRD to watch all of the programmes, even if they were scrambled under the control of other control access systems. This requires an agreement among the different programme providers.

DVB-TXT specifies how to receive the "traditional" Teletext used in analogue TV (EN 300472).

In order to interact with viewers, DVB specifies two sets of protocols: the first protocol stack covers approximately the ISO/OSI link and network layers, the second, the media and the link layers.

An important part of the first stack refers to the Digital Storage Media Command Control (DSM-CC) protocols of MPEG (ISO 13818-6).

The second set describes how to use various transmission networks for interaction (upstream from the viewer to the programme provider): these nets include PSTN (Public Switched Telephone Networks), ISDN (Integrated Services Digital Networks), DECT (Digital Enhanced Cordless Telecommunications), GSM (Global System for Mobile communications) and LMDS (Local Multi-point Distribution Systems).

In the near future, specifications will be designed to connect TV systems to the outside world of interactivity via Very Small Aperture Satellite Transmission (VSAT) and which can be used for the interaction channels accompanying terrestrial DVB.

The basic broadcast service of very large amounts of data at high data rates with a high degree of security, availability and reliability (including the possibility of repeat transmissions of the same data at regular or irregular time intervals) is detailed in the document EN 301192, which describes the four application areas of data piping, data streaming, multiprotocol encapsulation and data carousel.

4.9. The Internet evolution

As pointed out in the first section, the Internet is the key driver for the entire ICT world in all of its architectural, infrastructural and application aspects; the Internet evolution is therefore considered in all sections of the present chapter. Here we shall discuss only some specific new items relating to telecommunications.

The success and power of the Internet are based on the voluntary, unregulated and non-proprietary environment that has led to the establishment of a truly universal and uniform open infrastructure.

Looking at the Internet from the TLC point of view, two main innovative directions can be identified: the evolution of IP logic and the new high level protocols and services.

The IP evolution is strictly related to the switching evolution discussed in 4.2. and 4.3., and has the aim of reaching mega and tera mps communication speeds.

Internet challenges concern evolving standards and regulatory frameworks, the rapid and flexible turnover between old and new technologies, the cheap and pervasive availability of points of access, and secure transactions particularly for E-commerce.

Internet technologies also play a growing role as a reference framework for enterprise-business ICT architecture (Intra- and Extranets), the multimedia environment (particularly thanks to audio and video streaming), and finally for traditional telephony.

4.9.1. Voice over IP (VoIP)

As mentioned at the beginning, telephone traffic is moving from circuit switching to IP, ATM and Frame Relays. Transporting voice over IP (VoIP) is growing with the aim of reducing telephone and fax costs and starting the deployment of advanced multimedia applications. Providing high quality telephony over IP is a key step in multimedia convergence.

A sure sign that the technology has grown from fad to must-have is the fact that some big-name players have entered the market: e.g., Bay Networks Inc. [http://www.bay.com], Cisco Systems Inc. [http://www.cisco.com] and 3Com Corp. [http://www.3com.com] are all integrating VoIP into their products.

These devices are like routers or RACs (remote access concentrators) with VoIP cards slotted in as extras, or a standalone chassis or PC server that takes voice cards.

Routers and concentrators can move calls faster than standalone gateways because they insert packets into the router queue and out to the wide area via the WAN interface, whereas standalone chassis or PC gateways send data through an Ethernet interface and force it to travel across the LAN to get to the router. Direct access confers another benefit: limited prioritisation. Standalone devices cannot bump voice packets to the head of the router queue.

The devices with T1 (1.544-Mbit/s) interface support 24 ports; E1 (2.048-Mbit/s) interface cards support 30 ports. Their scalability depends on the number of slots: small systems deal with 168 and the largest ones as many as 10,560 simultaneous calls. The calls are checked in order to distinguish fax and voice traffic. Depending on the type of traffic, the equipment allocates different-sized buffers (larger for fax) and also encodes the calls differently because voice can withstand the pressure of compression better than fax and modem calls.

Although VoIP systems are still proprietary, the majority of the manufacturers are adopting the ITU standard G.723.1 for encoding voice. This is used to provide interoperability among different systems and can also compress voice to 6.3 or 5.3 kbit/s, depending on the configuration.

4.9.2. Internet2 and NGI

Next Generation Internet (NGI) and Internet2 (I2) are two strictly related and not alternative USA projects that are going to develop the new generation Internet and will solve all of the present infrastructural limitations for academic environments. They are supported by the university community together with government and industry partners. The limitations to be solved include the limited network capability for supporting world-class research and the lack of advanced broadband services and applications now needed for meeting emerging academic requirements in the fields of research, teaching and learning: in particular, multimedia integration, interactivity, and real-time collaboration. This effort is essential for supporting educational objectives such as distance education and lifelong learning both nationally and internationally.

NGI [http://www.ngi.gov/] is an initiative of the USA Government for the development of advanced Internet technologies and applications that are between 100 and 1,000 times faster *end-to-end* than today's Internet. The NGI consists of two new nets: one for the R&D environment, with more than 100 sites connected at 100 Mbps, the other, an experimental net connecting ten sites at 1 Gbps.

Internet2 (I2) [http://www.internet2.edu/] is a project of the University Corporation for Advanced Internet Development [www.ucaid.edu], based on a non-profit consortium of 120 universities, public organisations and manufacturers, with the aim of developing a high bandwidth network for the R&D and Internet communities. I2 is already in operation and is based on a OC-3/OC-12 backbone (HPC/vBNS, see below).

The technical objectives of Internet2 include:

- the development of one or more very high capacity advanced function packet data switches/routers capable of supporting at least OC-12 (622 megabit/second) link speeds and switched data streams, as well as packet data routing;
- switches/routers supporting both version 4 and the new version 6 Internet Protocols, advanced routing protocols such as MOSPF, and "Quality of Service" protocols such as RSVP;
- SONET or ATM multiplexers to enable the allocation of link capacity to different services such as highly reliable IP packet delivery, experimental testbeds for emerging protocols, or special requirements determined by new initiatives among the Internet2 member institutions;
- traffic measurement and related data gathering to enable project staff to define flow characteristics as part of the operational and performance monitoring of GigaPoPs (Gigabit for second Points of Presence).

The functional objectives are to maintain a common bearer service to support new and existing applications, move from best effort packet delivery to a differentiated communications service, provide the capability of tailoring network service characteristics to meet specific applications requirements, and to achieve an advanced communications infrastructure for the Research and Education community.

I2 has been designed to provide a variety of "on demand" services in support of advanced applications. These dynamically selectable services will include guaranteed bounded delay, low data loss, and high capacity. For example, in order to support delivery of advanced multimedia teaching materials from a digital library repository to a dispersed audience of learners, it is necessary for the service delivery infrastructure to support "multicast" data delivery with guaranteed upper bounds within the transport components on delay and data loss.

New protocols to enable this functionality have already been defined and will be deployed early in the Internet2 project. These include the IETF-defined quality of service protocols (such as RSVP and RTP with IPv6), the IETF-developed replacement for the current version 4 of IP. In addition, Internet2 will provide access to the underlying network infrastructure for those environments that can support such access and those applications that can make use of the specific capabilities offered by the infrastructure.

The heart of the Internet2 design is a new technology called GigaPoP (Gigabit for second Points of Presence) that provides regional connectivity among universities and other organisations; this technology is based on very high bandwidth ATM or SONET services and makes it possible to acquire "quality of service" dynamically (depending on the application needs of end-users), while maintaining a common interoperable "bearer service". The service characteristics include end-user definable capacity and latency. I2 is going to determine the incremental costs associated with the support of differentiated classes of service, and provide mechanisms and tools for collecting data concerning the use of these resources by individual users.

The Internet2 project should explore the issue of "middleware" in a high-bandwidth, low-latency, quality-of-service enabled network environment. The I2 architectural model, which is evolving alongside the project, will address all of the new ICT logics: from object technology to components, from compound document support to specific APIs, and from information resource metadata services to Network service level negotiation capabilities. I2 refers to an n-tier model in which multiple servers may be applied to a single application. An I2 client is normally a dedicated desktop system running a multi-threaded, multi-tasking operating system on a high-end processor with a high bandwidth connection (at least 25 Mbps). This may be the dominant but it is not the only platform. However, other devices, such as personal digital assistants (PDAs), laptops, portable intelligent phones and "set-top" boxes will very soon be connected in order to provide a mesh of connectivity in which an individual with multiple access devices can receive and communicate across a complex mesh of networks.

It is envisioned that the new capabilities of HPC/vBNS will make it the initial interconnecting network of GigaPOPs.

NGI and I2 co-operate in various ways. These include:

- the evolution of NSFnet of the National Science Foundation [http://www.nsf.gov/] into a vBNS, very high performance Backbone Network Service [htttp://www.vbns.net], with more than 70 High-Performance Connections (HPC) for universities awarded on a merit basis;
- the availability of I2 GigaPoPs allowing universities high-speed connections to NGI networks and other advanced Federal networks, including the vBNS, NASA's Research and Education Network (NREN) [http://www.nren.nasa.gov], the DoD's Defense Research and Education Network (DREN) [http://www.arl.mil/HPCMP/DREN/] [http://www.hpcmo.hpc.mil], and the Department of Energy's Energy Sciences network (ESnet) [http://www.es.net];
- the NGI and Internet2 will help ensure that advanced networking services are available on interoperable backbone, regional, and local networks that are competitively provided by multiple vendors.

5. Software technologies

As pointed out in previous reports, software technology acts as an enabling "glue" technology between hardware platforms, telecommunications networks and the human users of ICT systems, and is therefore not only driven by the evolution of these other macro-parts of the ICT world, but also has an impact that depends upon them.

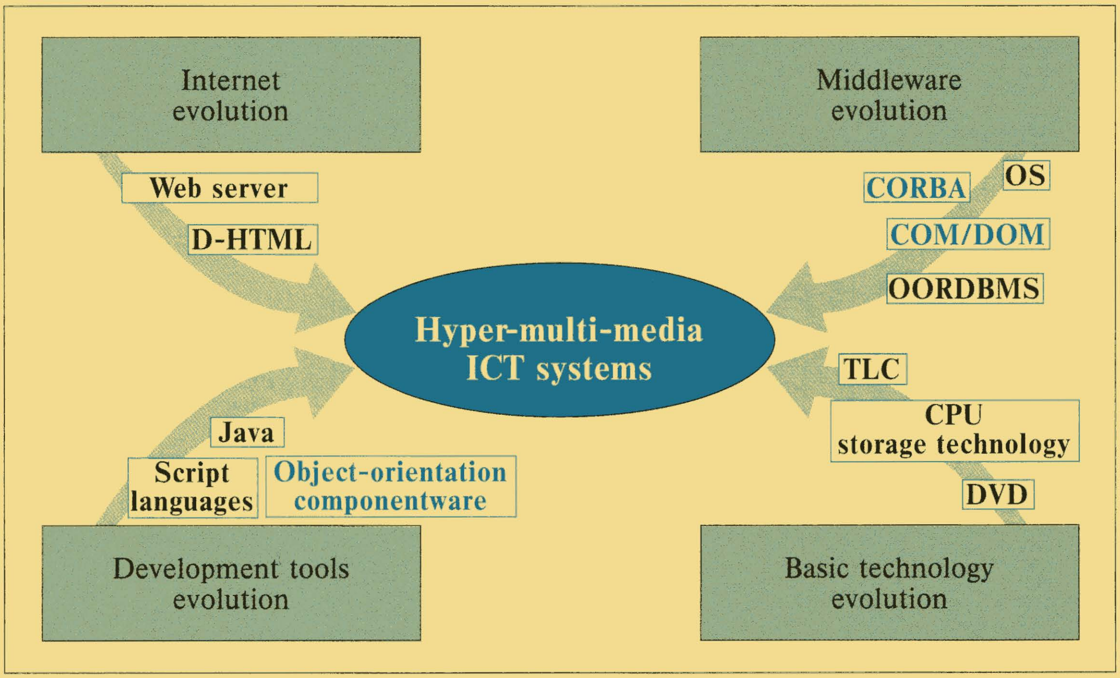
ICT systems are becoming increasingly complex because of the intrinsic complexity of the modern distributed, converging and multimedia context, and the additional complexity created by the need to offer users efficient, friendly and simple interfaces.

The innovation ratio in software has always been lower than that of hardware and TLC, and Year 2000 and Euro problems are further delaying its speed of evolution.

Flexibility, reusability, interoperability, object orientation and "more with less and now" are the musts of the software world. Software innovation is continuous but gradual, and no real paradigm shift has occurred over the last few months or is likely to occur over the next few months.

Once again, the Internet phenomenon is the key driver: the "Web-centric" approach dominates the latest major innovations at the level of middleware facilities, software development and applications. The Internet/Web-enabling convergence of different technologies (Internet protocols, browsers, multimedia techniques, middleware and development tools) is gradually but significantly creating a virtuous circle that takes the form of a positive concentric spiral *(Figure 16)* that standardises, reduces and simplifies (from a user point of view) development and application environments, reusable class libraries, programming languages and database interfaces, such as HTML, CORBA, ActiveX and Java.

Figure 16
The virtuous circle of software convergence



Internet impacts the software environment also by means of its widespread introduction of "try-before-buy" offers and huge amounts of essentially free software.

Previous EITO reports have already indicated a number of aspects related to this evolutionary context, but this convergence is now emerging more strongly and will drive not only the new Web-centric ICT architectures, but almost all of the software developments of the future.

The main pillars supporting this trend include:

- the evolution of HTML into D-HTML;
- the introduction of Extensible Markup Language (XML);
- the emergence of CORBA, JavaBeans and COM/DCOM as the competitive standards for middleware and componentware;
- the evolution of the development environments based on Java, script languages and programmable interfaces.

The development of Web applications is now also oriented towards those that are mission critical, and Internet/Intranet/Extranet techniques are changing the nature of transactions because today's systems must cope with long-lasting interactions, multiple parties both inside and outside corporate structures, and new security needs. Transaction processing systems will continue to become more sophisticated, and this will inevitably lead to changes in the logic and architectures supporting such a complex environment.

As pointed out last year, software agent technology is growing its role and usage. An agent is a software entity that assists people and acts on their behalf. It operates out-of-band with the user as his personal assistant, who learns what he likes and can anticipate what he wants or needs. The intelligent agents are increasing their capabilities, using artificial intelligence techniques (such as rules-based systems, memory and case-based reasoning systems, neural networks, etc.) and also communicating with each other, allowing collaborative sharing of information, learning, and smarter organisational systems.

5.1. System software and utilities

These primarily include strictly software governing operating systems, system utilities and system management, and the products on the market often include all of these functions in a single package (e.g. the Microsoft NT Server and Windows 95 operating systems). Although others support only one of these functions, they are portable and scalable on platforms ranging from PCs to mainframes.

The main drivers of innovation include:

- the consolidation of the open-system concept (in the sense established by the Open Group [http://www.opengroup.org/]);
- the integration of Internet logic, particularly user interfaces such as browsers and the support of Java and JVM (Java Virtual Machine) [http://java.sun.com/];
- the growing availability and acceptance of component software;
- the convergence towards a few competing standards for distributed component software;
- increasing scalability and portability on different hardware platforms.

5.1.1. The OS evolution

The basic characteristics of modern operating systems are deployed by almost all OS providers, although a rough distinction can be made between desktop and enterprise OSs *(Table 8)*.

For desktops, the migration from 16 to 32 bits is already under way.

Almost all of the modern OSs conform with POSIX/OSE standards (also see EITO 98 and EITO 97), and support different protocol stacks (typically TCP/IP and IBM System Network Architecture) and different types of databases.

Browsers such as GUIs (Graphical User Interfaces) make it possible to explore information and resources at both a local and network level (e.g. at a Web server).

Ongoing innovations include the growing OS support and integration of advanced middleware, security mechanisms and services, clustering and multiprocessor configurations.

The latest news concerning OSs is the growing acceptance of Linux even in enterprise environments, and the introduction of Windows 98 and Apple Rhapsody.

There is no *de facto* or *de jure* standard concerning consumer electronics and information appliances, and a number of real-time OS manufacturers are competing in these nascent markets. The reference products at the moment are Microsoft's Windows CE, Sun's PersonalJava and EPOC, supported by the Psion focused European consortium Symbian [http://www.symbian.com].

5.1.1.1. Unix world

Unix systems are playing the main role on Internet/Intranet/Extranet as Web-servers

The "Open Group" [http://www.opengroup.org] not only standardises Unix specifications, but also awards the Open Brand to all of the

Table 8
Comparison of some basic characteristics of modern operating systems

	Multi-thread	Multi-tasking	Symmetric MultiProcessors (SMP)	Virtual memories	Windows	Portability
MS-DOS						
Windows 3.x					x	
Windows 9.x	x	partial		x	x	
Windows NT	x	x	x	x	x	limited
Mac OS				x	x	
Rhapsody	x	x	x	x	x	x
OS/2 Warp	x	x	x	x	x	
Unix	x	x	x	x	x	x
Linux	x	x	x	x	x	x
IntraNetware (Novell)	partial		x	x	x	
OS/400	x	x	x	x	x	limited
OS/390	x	x	x	x		

products that conform to them. This “X” mark guarantees the present and future conformity of the product, and also guarantees that any faults will be corrected within a prescribed time-frame.

The Unix 98 Product Standard is an enhanced version of Unix 95. The mandatory enhancements include thread interfaces, Multibyte Support Extension (MSE), large file support, dynamic linking, changes to remove hardware data-length dependencies or restrictions, and Year 2000 changes. The optional enhancements include software administration facilities and a set of APIs for real-time support. On the basis of Unix 98, the Open Group details the Workstation and Server Product Standards: the first is the same as Unix 98 except for the addition of the Common Desktop Environment Product Standard; the server adds interoperability to support Internet and Intranet services, including the support of network computer devices and the presence of a mandatory Java execution environment.

The X/Open Common Desktop Environment (CDE) [http://www.opengroup.org/] defines a standard common graphic user interface for systems supporting the X Window System, with facilities such as windowing and window management, session management, file management, electronic mail, text editing, calendar and appointments management, calculator, application building and integration services, print job services, and a help service.

The new element in the Unix world is Linux, a completely free reimplementation of the POSIX specification that is available in both source code and binary forms. Linux, which now has about seven million users was invented eight years ago by Linus Torvalds of the University of Helsinki. It has since spread as an alternative to the proprietary Unix and Microsoft’s Windows NT operating systems. By many accounts, Linux is now the fastest growing Unix platform despite the fact that it has so far been primarily known in the academic and amateur environments [http://www.linux.org/].

5.1.1.2. Windows world

At client level, Windows 3.x and 9.x are dominating the market. The new entry is Windows 98, which is more oriented to home than professional PCs. Windows 98 can use the browser as the user interface and supports multimedia facilities, USB, DVD, and also up to eight monitors in parallel on a single machine. For the enterprise environment, the most advanced OS is NT Workstation 4.0, which will soon be enhanced by the introduction of the new 5.0 version. NT 4.0 is a 32-bit OS that supports SMP configurations, pre-emptive multitasking, file system FAT, NTFS and DCOM. Version 5.0 is the result of a major effort to produce a robust, reliably secure, full-featured desktop OS that will provide all of the latest innovations, including ACPI (Advanced Configuration and Power Interface), AGP, Plug&Play, Direct X 5.0 for multimedia, FAT 32 and DFS (Distributed File System, which makes it possible to manage multiple disks as a unique virtual disk), and enhanced security via Kerberos and encrypted files.

At server level, the NT 5.0 Server now named Windows 2000 will be the top reference point for the Windows family. It includes all of the key characteristics of the present version 4.0, as well as those of the recent product bundle (the Enterprise Edition) of the Internet Information Server (IIS), Cluster Server (MCS), Transaction Server (MTS), Message Queue Server (MSMQ). NT Server 5.0 also adds new features including a new directory service and an advanced management system along the lines of the Zero Administration Windows (ZAW) initiative for reducing the total cost of ownership (TCO).

Windows CE is a pre-emptive, multi-tasking, multi-threaded 32-bit OS for hand-held computers, sub-notebooks, set-top box and (in the future) info appliances. The latest version is CE 2.0.

5.1.1.3. Java world

Most operating systems support a Java Virtual Machine (JVM) that makes it possible to run Java-written applications and applets. A JVM consists of a "bytecode" interpreter, a "class loader" linking and connecting local and remote classes, a bytecode verifier (which assures the correctness of the imported codes), run-time libraries including system, net and file accesses, and other basic functions.

The JavaOS layered architecture is divided into platform-specific and platform-independent codes: the former, which is compiled to the native code, consists of the multithreading microkernel and the JVM; the latter, which is written in Java, contains the windowing and graphics systems, device drivers, and supports for Java APIs. JavaOS is portable on several platforms, including x86, SPARC and StrongARM.

For the consumer electronic environment, Sun is introducing PersonalJava, an environment for tailoring a real-time OS customised for the specific tasks provided by the device (of course, using Java).

PersonalJava is a Java Application Environment (JAE) specifically designed for building network-connectable applications for consumer devices for home, office and mobile use. It consists of the Java Virtual Machine and a subset of the Java Application Programming Interface (API), including core and optional APIs and class libraries.

5.1.1.4. Other OSs

The traditional IBM OS family [http://www.ibm.com], which consists of MVS (Multiple Virtual Storage), VSE (Virtual Storage Extended) and VM (Virtual Memory), is still dominating the mainframe server segment; all of these OSs are continuously upgraded and conform with Posix (i.e. the "Open Systems" standards of the

Open Group). The main innovation concerns MVS (now called OS/390, and at Version 2 Release 4), which provides digital certificates, firewall technologies, other security facilities and Internet web server functions, such as Domino Go Webserver, Java (a JVM on 390 platforms) and E-commerce.

At the lower level of enterprise servers, the main innovations relate to the latest version of IBM OS/400, IBM OS/2 Warp and the new Novell IntranetWare, which is an evolution of the Netware NOS (Network Operating System), leader in the file and printer sharing OS/NOS segment. The "proprietary" IBM OSs conform with Posix and CORBA, and support Java-JVM and a number of Internet web server functions like the bigger OS/390. Some of them also provide advanced directory services and support NT and Unix.

At client level, the main innovations are the evolutions of IBM OS/2 and Apple MacOS, and the new Rhapsody by Apple [http://www.apple.com].

OS/2 Warp 4.0 functionally competes with NT Servers based on 32-bit architecture, and provides strong support for Java. Some of the key advances are its interoperability with NT and Unix servers (Picasso), the emulation of the Windows Terminal Server (Hydra), integrated connectivity to mainframes and minicomputers, and voice-recognition. Apple MacOS (now at version 8) is a 32-bit OS that supports various multimedia standards such as QuickTime, QuickDraw 3D and MPEG. Rhapsody, which is derived from NeXT, is designed to overcome the fact that MacOS lacks some of the high-end features provided by OS/2 and NT. Rhapsody is a multi-threaded, pre-emptive, multi-tasking OS, with a protected memory and SMP. It will run all of the applications developed for Mac environments.

5.1.2. The evolution of middleware and componentware

The generic term *middleware* refers to a wide range of "basic" software that offers a solid interface for programming by hiding the specific characteristics of the hardware, the communications protocol stack, the operating system and, in some cases, even the different programming languages. It has been mainly designed for distributed and heterogeneous applications over n-tier architectures, which overcome the traditional two-three tiers and better represent the present Internet-Web-centric situation, with different servers accessing various databases, and accessed by different clients (from dumb terminals to Windows PCs and Unix workstations).

Middleware is greatly affected by, and in turn influences, software component architectures and their related development tools. Although the "state of the art" is still far from reaching common approaches and mature standards, the present virtuous software circle is restricting the emerging standards to CORBA, ActiveX and JavaBeans.

All of these standards are based on a model of distributed objects characterised by standardised interfaces and the universal Internet TCP/IP transport protocol. This implies a "componentware" logic that has a direct impact on the development tools: in some cases, the term *object* is even used as a synonym of *component.*

5.1.2.1. OMA, CORBA and IIOP

Since the first version of Common Object Request Broker Architecture (CORBA: also see EITO 95) standardised by the Object Management Group (OMG) [http://www.omg.org], a number of major updates have been introduced (it is now at version 2.1). CORBA acts as the interconnection bus in a component architecture called Object Management Architecture (OMA: see *Figure 17*). One of its key characteristics is that the interfaces are defined by the

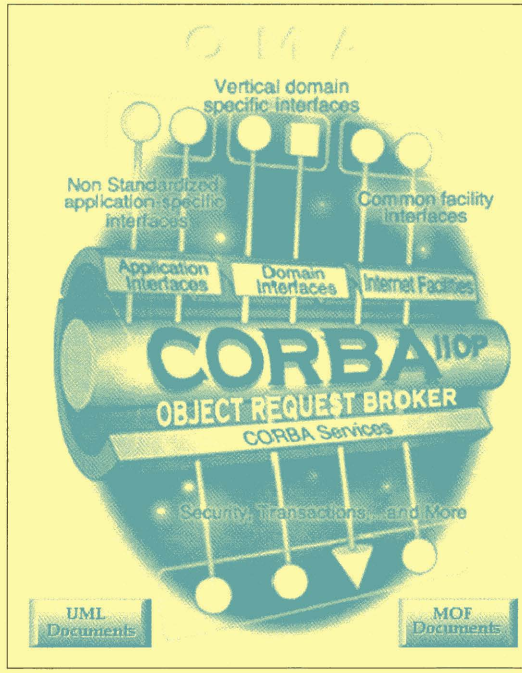
CORBA Interface Definition Language (IDL), whose syntax is very similar to that of C++, regardless of the specific platforms and development languages used. The IDL specification is code mapped for the component by means of a translator (client stub and server skeleton codes), which ensures object/component interoperability. The IDL interface definition is stored in the ORB's Interface Repository.

CORBA uses Object Request Brokers (ORBs) to manage requests from programmes to components, as well as between components. An ORB provides a mechanism for transparently communicating client requests to the target objects (local or distributed in the network) as if all of them were local procedure calls. When a client invokes an operation, the ORB is responsible for finding the object implementation, transparently activating it if necessary, delivering the request to the object, and then returning any response to the caller. Components can be invoked via client IDL stubs (static invocation) or dynamically. In the case of dynamic invocation *(Figure 18)*, the client retrieves the requested object from the Interface Repository (i.e. the invoking programme does not know whether this object exists or where, and therefore cannot have a stub code already available); in the case of static invocation, the client programme has *a priori* knowledge of the required object.

The Internet Inter-ORB Protocol (IIOP) is an extension of CORBA version 2.1 that allows different ORBs to intercommunicate by means of some specific message formats added to those of the standard TCP/IP.

CORBA 2.0 is also the kernel of the Object Transaction Monitor (OTM), the new boundary of the middleware evolution that combines and integrates the features of TP monitors with those of message queuing and ORB.

Figure 17
OMA and CORBA



Source: OMG

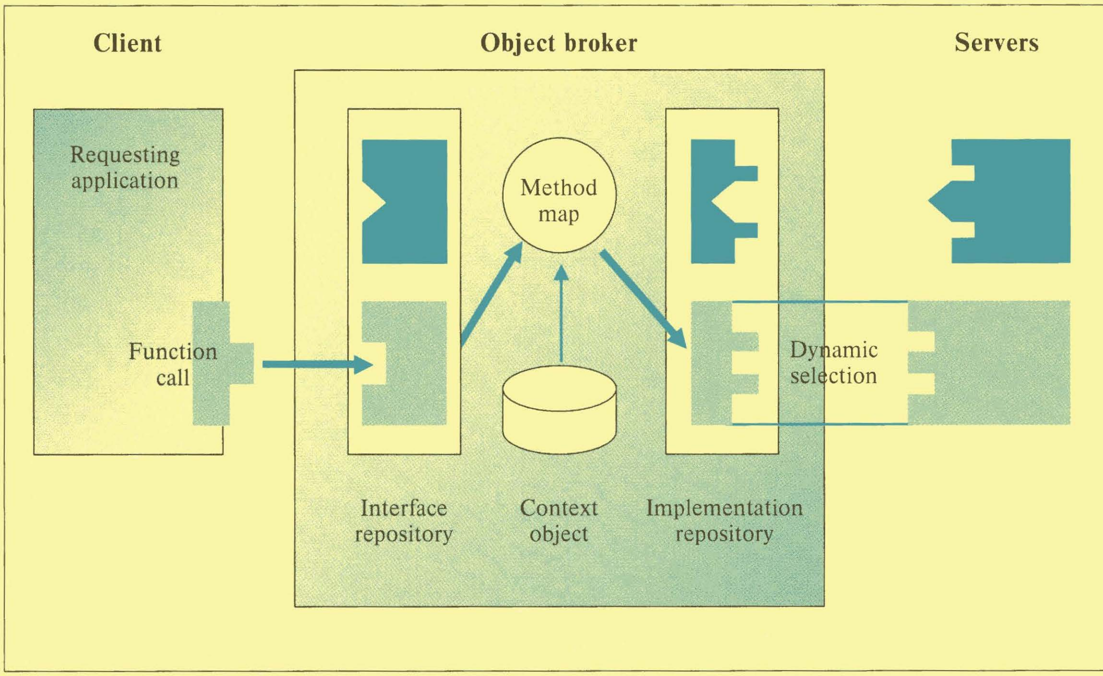
5.1.2.2. Evolution of COM/DCOM: COM+, MTS, MSQS

COM/DCOM (Component Object Model/ Distributed COM) is Microsoft's component architecture, which is functionally similar to CORBA but designed to allow interoperability among Windows platforms and also includes Open Group standards.

The widespread acceptance of COM by Window's developers is also due to the existence of a number of common development tools.

In general, COM can be considered an abstraction of OLE objects based on the concept of their COM class (identified by a unique and universal identifier) and the System repository that maps it to a specific executable code in the form of COM objects (e.g. ActiveX).

Figure 18
Basic scheme of a dynamic invocation



Source: OMG

COM provides a means by which software components can communicate with each other. It is a binary and network standard that allows any two components to communicate regardless of the machine they are running on (as long as the machines are connected), their OS (provided that it supports COM), and the language in which the components are written. COM also provides location transparency: i.e. when the components are written, it is irrelevant whether the other components are in-process DLLs, local EXEs, or components located on another machine.

Microsoft has announced plans for its COM+ extension that builds on COM's integrated services, and makes it easier for developers to create and use software components in any language and by means of any tool. The applications currently using COM technology will also work in the COM+ environment, and developers can choose to take advantage of the new optional services that COM+ provides in key areas such as database access.

The Distributed Component Object Model (DCOM) is a protocol that enables software components to communicate directly over a network. Previously called "Network OLE," DCOM is designed for use across multiple network transports, including Internet protocols such as HTTP. DCOM is based on the Open Software Foundation's DCE-RPC spec and will work with both Java applets and ActiveX components through its use of the Component Object Model (COM).

In order to overcome some of the intrinsic limitations of the RPC-based solution for DCOM, further protocols/application environments have been added, thus creating an Active Server that assembles server class capabilities for transaction and courier services for COM-interfaced components. These new parts include

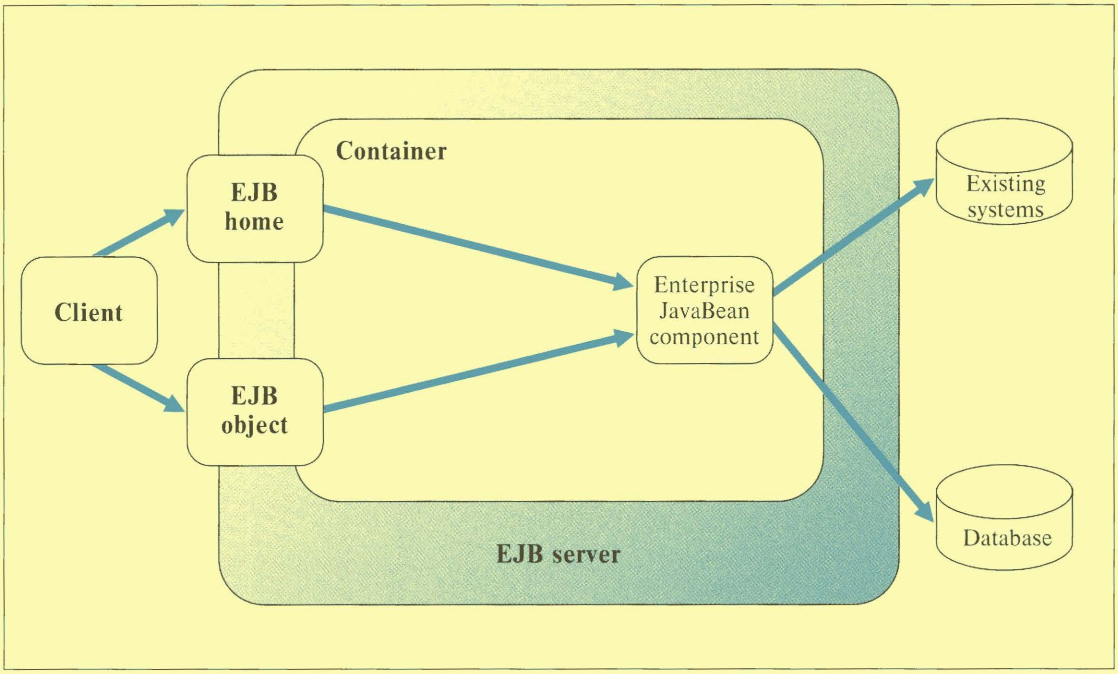


Figure 19
EJB architecture

Source: Sun

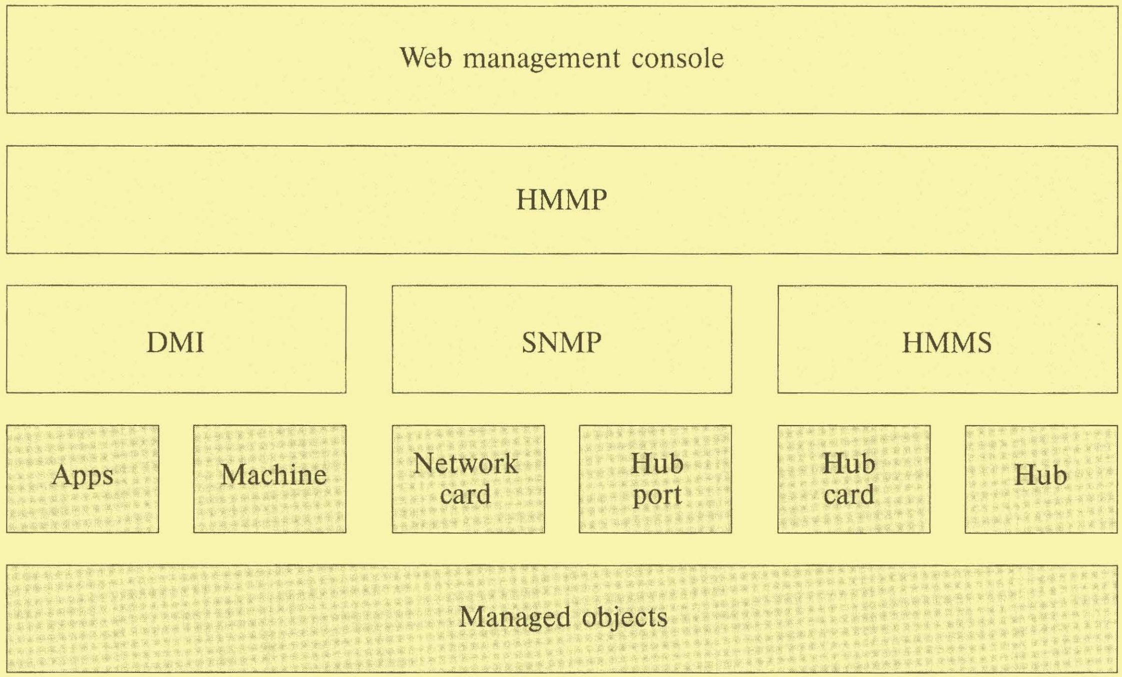
the Microsoft transaction server (MTS) and Microsoft Message Queue (MSMQ). The first is a TP system for NT servers designed to aid the development of distributed, component-based transactional applications that also allows asynchronous operations by means of MSMQ (originally called Falcon), a system that enables two applications to interoperate via queuing messages.

5.1.2.3. JavaBeans and Enterprise JavaBeans

Java-based component logic is made up of Java APIs and JavaBeans (the latter specifying the Java language component: the coffee metaphor continues . . .). A Bean is a piece of Java and object-based software that can be combined with others in order to create applets and applications: it cannot be executed directly, but has to be inserted in a container known as a hosting application. Beans are to Java what OCX/ActiveX objects are to OLE. They are primarily specialised visual-component Java class files based on existing Java objects, but their new features include introspection and persistence, and any Java object that implements at least one of these features is considered a Bean. Introspection makes it possible to examine a Bean's data structure (e.g. methods, instance variables, properties and interfaces); persistence allows Beans to memorise any changes in their properties permanently (objects otherwise normally revert to their default properties).

Enterprise JavaBeans (EJB) is the server side component architecture whose EJB 1.0 specification was released during 1998 with the aim of facilitating the development of n-tier, distributed applications as re-usable server components (see *Figure 19*). It represents an extension

Figure 20
Web-based Enterprise Management (WBEM) architecture



of JavaBeans, which was originally oriented towards a set of client-side GUI components.

Both JavaBeans and EJB are CORBA-compliant. The EJB architecture is multi-platform, which means it allows any type of client and supports multiprotocols such as IIOP and DCOM.

One of the key features of EJB is its support for distributed transactions, which can access multiple distributed databases through multiple EJB servers.

5.1.3. Management systems

The need for global integrated systems and network management is increasing as a result of the growing complexity of modern ICT systems and networks; there is also a growing need to reduce the total cost of ownership, particularly in the case of distributed environments. These needs are leading to the development of more automated and more intelligent system management systems involving the greater use of Internet technologies.

The traditional areas of performance, fault, configuration, billing and security management are being extended to cover all ICT resources (from network units to desktops, and from middleware to applications), and key roles are increasingly played by security and by directory services.

The reference standards for system management are primarily the Simple Network Management Protocol (SNMP) and RMON 2.0 (Remote Monitoring), to which it is possible to add Web-Based Enterprise Management (WBEM) and Desktop Management Interface (DMI).

Those relating to both centralised and distributed Directory Services include X.500, the Domain Naming System (DNS) and the Lightweight Directory Access Protocol (LDAP).

As also described in previous EITO reports, the latest versions of SNMP and RMON are mainly concerned with the monitoring and control of specific network resources and end-to-end communications.

The forthcoming IETF-standardised SNMP Version 3 will allow manager-to-manager communications, HTTP, and user interface browsers.

Initially developed by the homonymous Consortium, WBEM has been transferred to the Desktop Management Task Force (DMTF) [http://www.dmtf.org/] and has now gained widespread manufacturer support and led to the development of a number of compliant products. Its purpose is to consolidate and unify the data provided by existing (particularly SNMP and DMI) management technologies. WBEM does not replace existing management standards, nor preclude proprietary or platform-specific frameworks such as NDS, but is intended to complement and integrates these standards by providing a single point through which the data originating from all such sources can be accessed.

The architecture of WBEM is shown in *Figure 20,* in which the HyperMedia Management Schema (HMMS) is the model for data presentation and the HyperMedia Management Protocol (HMMP) is a management protocol that uses HTTP.

Developed by the Desktop Management Task Force, DMI is now at release 2.0, which standardises all of the hardware and software elements of a desktop (motherboards, processors, operating systems, etc.), and allows remote control and monitoring via telephone lines, agents, and diagnostic routines.

Now at version 3.0, LDAP has been designed to facilitate access to X.500 and represents a modification of the DAP (Directory Access Protocol) portion of the X.500 directory service. It does not require a database, because it is just a protocol for accessing X.500 databases.

LDAP 3 includes internationalizsation, support for schema discovery and guidelines for extending the protocol, but lacks multimaster replication and security features.

5.2. Application development tools

Development tools are evolving as rapidly as all other aspects of ICT, focusing on the one hand on object-oriented programming and Web environments and, on the other, Rapid Application Development (RAD) also for large and complex distributed environments. Software component architectures, such as CORBA, COM/DCOM and JavaBeans, constitute the bases for modern object-oriented, component-based programming environments.

As pointed out in EITO 98, UML (Unified Modelling Language [http://www.dse.doc.ic.ac.uk/local/uml/uml.html]) is an important trend addressing development speed, code reliability, code and design reuse of object-oriented systems. UML is the reference standard for the specification, realisation, documentation and visualisation of OO systems.

Within this general trend, the problems of Year 2000 and the introduction of the Euro have generated a niche of specific tools (particularly for Year 2000 analysis and conversion) which are absorbing a large portion of total ICT expenditure.

Table 9
The main scripting languages

Language	References	Key characteristic
ECMAScript	http://www.ecma.org	Standard version of JavaScript
JavaScript	http://developer.netscape.com/one/javascript	Designed to be incorporated in browsers
MetaCard	http://www.metacard.com	Easy to learn, but not yet widespread
Perl	http://www.perl.org	Sophisticated interpreted language for text manipulation. Widely used for CGI* processes
Python	http://www.python.org	Portable and maintainable language, but not yet widespread
REXX	http://www.rexxla.org	Specific language for all IBM platforms and OSs
Tcl	http://www.tclconsortium.org	Oriented to the Unix world and used for CGI* processes
VBScript	http://www.microsoft.com/scripting/vbscripting	Based on a subset of Visual Basic for Applications (VBA)

* CGI (Common Gateway Interface) is one of the first mechanisms for interaction between HTML pages and other programmes or data bases on the Web. CGI is normally written in a script language.

5.2.1. Languages

The key potential of Java is its capacity to allow easy access and interoperability in relation to different platforms and environments. By means of its standardised APIs, Java enables existing data and applications (legacy systems, mainframes, etc.) to be bound to Internet environments, particularly WWW applications.

To accomplish its fundamental goal of interoperability, Java offers:

- an object-oriented, multi-threaded C/C++-like language;
- a Virtual Machine (i.e. a computer model in software to which Java code is written);
- a collection of machine-independent APIs;
- JavaBeans component architecture.

Consequently, unlike those of other codes, 100% pure Java solutions are written to the universal Java Virtual Machine and can thus run on the hardware and operating system of choice.

5.2.1.1. Scripting languages

Scripting languages are taking on an increasingly significant role in the evolution of dynamic web applications and have become a factor of differentiation among the different browsers. They act as a "glue" for assembling different components in a whole and can conceptually be seen as "drivers": i.e. the controllers of actions performed by other modules outside the script. They are simpler to learn and use than the traditional C, C++ and Java languages, and are also widely supported. Scripting languages are interpreted or compiled: the former can be ported and run unchanged on any platform with an interpreter; the latter depend on the platform used for their compilation but run much faster than interpreted languages. Applications written with either compiled or interpreted scripting languages normally run more slowly than the same applications written using third-generation languages (such as C), but are much faster to develop.

Table 9 lists some of the most commonly used scripting languages, comparing their key characteristics.

5.3. Databases and data warehousing

The role of databases is becoming crucial within the increasingly complex systems area because they contain information, a vital asset of any organisation.

The two main directions of evolution discussed in previous reports have been confirmed: the first is technological, such as the use of object technology in relational databases (RDBMS, Relational Data Base Management System), Web interfaces and in new search engines; the second involves the construction of new structures for information management, such as multidimensional DBs and "data warehouses", or for specific functions, such as OLAP (On Line Analytical Processing), the MOLAP evolution (Multi-dimensional OLAP) and ROLAP (Relational OLAP).

The key players include a few large companies that deal with the database infrastructure, and various smaller companies with specific products and tools dedicated to some of the functions of the whole process, such as design tools, access tools, data mining, etc.

From the standardisation point of view, the situation is confusing: there are very few *de facto* or *de jure* standards, and these are only partially followed by the manufacturers.

5.3.1. Metadata

In data warehouse environments, and more generally in complex client/server and ERP environments, "metadata" (or information concerning enterprise data) is becoming a critical element in effective information resource management.

To enable full-scale enterprise data management, different IT tools must be able to access, update and share metadata freely and easily. The only viable mechanism for enabling different tools from different vendors to exchange metadata is a common metadata interchange specification with guidelines governing the compliance of the various tools.

.firm	Business
.store	Sales
.web	Web sites
.arts	Culture and entertainment
.rec	Recreation
.info	Information services
.nom	Personal sites

Table 10
New generic top-level domain names

The standardisation process primarily refers to Metadata Interchange Specification (MDIS) by the Meta Data Coalition [http://www.mdcinfo.com/], a non-profit consortium of vendors and end-users founded in 1995 whose goal is to provide a tactical solution for metadata exchange. The results of this collaboration will provide the enterprise market with:

- a technology-independent, vendor-neutral information model describing the structure and semantics of metadata,
- an implementation-independent XML-based interchange format for metadata, and
- a platform for vendors and end-users to collaborate on the design of the above.

Metadata Exchange (MX) architecture by Informatica [http://www.informatica.com/] is another widely supported initiative for addressing the challenge of integrating decision support metadata between operational systems, data warehouse repositories and desktop query and reporting tools.

For other references to metadata standards refer to [http://www2.echo.lu/oii/en/meta.html].

5.4. The Web

5.4.1. Naming domains

Due to the universality of the Internet and its very large numbers of users, domain naming is becoming a worldwide problem: who is responsible for the registration and administration of domain names, and how can this be done in order to ensure the proper association of popular names with trademarks, and the creation and assignment of new domain names throughout the world? A domain name has a business value and therefore a large number of organisations are involved in the registration process. Until March 1998, the Internet Assigned Numbers Authority (IANA) handled the top-level domains .com and .gov, and the USA National Science Foundation was in charge of administering second level .com, .net and .org domains. IANA has now been replaced by ICANN (the Internet Corporation for Assigned Names and Numbers), a non-profit corporation created to take over responsibility for the IP address space allocation, protocol parameter assignment, domain name system management, and root server system management functions previously performed under U.S. Government contract by IANA and other entities [http://www.icann.org/].

The International Ad Hoc Committee (IAHC) has proposed a plan to allow an unlimited number of registration organizations and to increase the generic top-level domains as shown in *Table 10*.

5.4.2. Uniform Resource Identifiers (URIs)

The Internet world is also trying to rationalise and improve the general scheme for naming, describing and retrieving resources on the Internet. To do this, the Internet Engineering Task Force (IETF) [http://www.ietf.cnri.reston.va.us/] is introducing the concept of Uniform Resource Identifiers (URIs), which should bring together Uniform Resource Locators (URLs), Uniform Resource Names (URNs), Uniform Resource Characteristics (URCs), and whatever else the IETF working group considers useful for the purpose.

URLs confuse the name of a resource with its location, and the URI working group wants to move the Web and other Internet services to a scheme where a name (URN) is assigned to a resource, and the URC describes the resource characteristics (such as author, title, subject). It will also contain the locations for the resource as a set of URLs.

URIs are short strings that identify resources in the Web: documents, images, downloadable files, services, electronic mailboxes and other resources. They make resources available under a variety of naming schemes and access methods such as HTTP, FTP and Internet mail addressable in the same simple way. URI is an extendible technology: there are a number of existing addressing schemes, and more may be incorporated over time.

5.4.3. Dynamic HTML and Cascading Style Sheets (CSS)

The browser evolution is based on the development of HTML into Dynamic HTML (D-HTML) for transforming the present more or less static Web pages into an interactive multimedia format.

HTML specifications are set by W3C [http://www.w3.org/], and the present browsers and Web developments tools are at releases ranging from 2.0 to 3.2. The next product will be HTML 4.0.

The weaknesses of the previous versions of HTML include link tracking, syntax checking, extendability, data interchange, character internationalisation, object orientation, information reuse and dynamic content. Animation and dynamic content are provided by proprietary plug-ins or Java applets, but these solutions do not provide the interactive level of today's multimedia applications. Once a page is loaded into a browser window, it does not change in form or content unless it is reloaded. The search for specific content on the Web/Internet normally requires a long wait, and the result is a long and often irrelevant list of all of the possible matches. If a URL is changed, the name has to be changed (manually) on each page linked to it. Pages with dynamic or frequently updated content require a frequent exchange with the server, thus overloading both it and the network. The page contents have to be reformatted for export to other media such as paper or CD-ROM.

In order to overcome these weaknesses, a number of innovations are already or will soon be on the market under the general and generic name of D-HTML, which does not yet correspond to any specific standard or product, but rather to an approach and a set of logically/ functionally interrelated (but not always compatible and integratable) tools.

At the moment, a developer of dynamic pages has to combine different approaches: HTML 4.0, CSS, script languages and DOM, or use a new environment such as XML.

CSS (Cascading Style Sheets) is a W3C standard for D-HTML that allows content to be displayed with a high degree of flexibility and accuracy by defining fonts, margins and line spacing for different parts of an HTML document, the absolute positioning of content by specifying x-, y-coordinates, and also the overlapping of different elements by means of a z-index.

By using absolute positioning, the content of a document can be positioned and animated, its appearance can be changed at any time, and the content itself can be created on the fly.

CSS has a strong orientation to objects, particularly referring to the W3C Document Object Model (DOM, which is now a draft recommendation as part of the D-HTML proposal), and also allows Web page inheritance.

CSS2 became a Recommendation in May 1998 and, among other things, adds support for device-specific style sheets: for example, one style sheet may describe the presentation of a document on a speech synthesizer and another how the same document is presented on a TV device. The device-specific style sheets "shield" the underlying documents which can thus remain device-independent.

At present, only the CSS standard exists and is deployed by the main browser manufacturers. However, the latest versions of the main browsers (particularly IE4 and Navigator 4) manage the dynamic presentation of Web content in different ways, mainly depending on the different script languages, object libraries and environments they support.

HTML 4.0 allows the incremental display of large tables, scrollable tables with fixed headers, easier ways for printing long tables, and more flexible forms.

The set of HTML elements has now stabilised at about 80, with new elements being slowly added by the W3C working group on HTML that publishes revisions of the HTML specification. HTML 4.0 is the latest version and contains several noteworthy features for content providers. It deprecates the use of a large set of elements that mainly encode presentation, with their function being better served by style sheets.

Secondly, it gives all elements a "CLASS" attribute by means of which thay can be subclassed into categories of choice that effectively create new elements. The CLASS attribute can hold information which would otherwise be lost when converting a document to HTML, and a style sheet can act on the value of the CLASS attribute. The following examples explain this

Example A:

<author>

<name>Marco Bozzetti </name>

<email>marco.bozzetti@eni.it </email>

</author>

Example B:

<DIV CLASS=author>

<DIV CLASS=name> Marco Bozzetti </DIV>

<DIV CLASS=email> marco.bozzetti @eni.it </DIV>

</DIV>

5.4.4. Extensible Markup Language (XML)

Standardised by W3C, the introduction of XML was one of the most important events occurring within the Web evolution. It defines document structures (referring to the DOM architecture), rather than how a document can be displayed by a browser. The present browsers that manage HTML documents cannot deal with XML, but the future HTML standard will process and mix both HTML and XML. HTML describes how to present information, whereas XML describes the content. XML derives from SGML (Standard Generalised Markup Language), a metalanguage that specifies the mark-up language grammar for each document by means of Document Type Definitions (DTDs).

XML can be considered a kind of light SGML: it is easier to learn and use, and has the key characteristic of being "extensible". If a change is needed, XML does not need a formal update of the standard, but only the specification of an extension that will become universally available.

XML defines the DTD, XSL (Extensible Style Language, which is similar to HTML's CSS) and XLL (Extensible Link Language, for automated link management if a URL is changed).

In XML syntax, DTDs are not mandatory: tags can be application-specific or imported from a public DTD. Also derived from previous work on SGML, XML industry applications include electronic commerce based on EDI (XML/EDI), Chemical Markup Language (CME), Mathematical Markup Language (MathML), Open Financial Exchange (OFX), Resource Description Framework (RDF), and the Channel Definition Format (CDF) proposal for push technology.

5.4.5. Synchronised Multimedia Integration Language (SMIL)

SMIL is a standard proposed by W3C that defines an XML-based language for controlling the what, where and when of media elements in multimedia presentations with streaming audio and video.

There is considerable interest in integrating and synchronising Web content with audio and video information transmitted over the TV signal.

In a SMIL presentation, all of the media elements (images, audio clips, video clips, animations and formatted text) are referenced by the SMIL file in a similar way to that in which an HTML page references its images, applets and other elements.

5.4.6. Document Object Model (DOM)

The Document Object Model (DOM) Level 1, defined as a W3C recommendation in October 1998, is a platform- and language-neutral interface that allows programmes and scripts to access and update the content, structure and style of documents in a dynamic manner. The

DOM provides a standard set of objects for representing HTML and XML documents, a standard model of how these objects can be combined, and a standard interface for accessing and manipulating them. The goal of the DOM specification is to define a programmatic interface for XML and HTML. It originated as a specification allowing JavaScript scripts and Java programmes to be portable among Web browsers, and is designed to be used with any programming language. In order to provide a precise, language-independent specification of the DOM interfaces, the specifications are defined in OMG IDL, as in CORBA 2. Language bindings for Java and ECMAScript are also provided, and various other IDLs could have been used. DOM can be implemented in any computing environment, and does not require the object-binding runtimes generally associated with such IDLs.

The DOM provides documents with a structure model to describe their tree-like representation. One important property of such models is their structural isomorphism: if any two Document Object Model implementations are used to create a representation of the same document, they will create the same structure model, with precisely the same objects and relationships.

As an object model (in the traditional sense of object-oriented design), the DOM identifies:

- the interfaces and objects used to represent and manipulate a document;
- the semantics of these interfaces and objects including their behaviour and attributes;
- the relationships and collaborations among these interfaces and objects.

The DOM Level 1 specification is separated into two parts: Core and HTML. The Core DOM Level 1 section provides a low-level set of fundamental interfaces that can represent any structured document, as well as define extended interfaces for representing an XML document. These extended XML interfaces are not implemented by a DOM implementation that only provides access to HTML documents; all of the fundamental interfaces in the Core section must be implemented. A compliant DOM implementation that implements the extended XML interfaces is also required to implement the fundamental Core, but not the HTML interfaces. The HTML Level 1 section provides additional higher-level interfaces that are used with the fundamental interfaces defined in the Core Level 1 section in order to provide a more convenient view of an HTML document. A compliant implementation of the HTML DOM implements all of the fundamental Core interfaces as well as the HTML interfaces.

6. Architectures, new services and applications

The convergence of cyber- and TVspace, the multimedia and Internet is laying the foundations for the Information Society by continuously stimulating innovation in applications and services not only for domestic markets and consumers, but also for businesses and enterprises. Multimedia techniques will become a *"conditio sine qua non"* for all ICT services and applications.

The killer applications will be E-commerce (see paper: "The E-commerce market in Europe" in Part Two) and knowledge management, and the second wave will consist of typical entertainment and educational programming services provided via the Internet and by means of video-on-demand, pay TV, pay per view, etc.

Although central and local public administration citizen services will also inevitably become an essential element of the Information Society, they are still in an embryonic stage (at least in Europe).

All of these multimedia applications and services require a growing network bandwidth together with higher performance client and server platforms with a greater memory capacity. The traditional two- or three-tier architectures are therefore developing into n-tier application architectures, with specialised transactional servers, database and data-warehouse servers, security servers, management servers, gateway servers, etc. These architectures must be "flexible": i.e. capable of guaranteeing not only functional interoperability and integration between new applications, ERPs (Enterprise Resource Planning) and legacy systems, but also the rapid deployment of new services and applications by drastically reducing development times. The "time" factor is becoming increasingly critical because of the year 2000 and the introduction of the Euro.

These Web-centric architectures will also lead to a growing focus on "content" because the strategic asset is the information itself, and not the tools for managing it. As a result, we shall see greater emphasis on the discipline knowledge management (KM), which will be developed by means of various applications ranging from data mining to ERP reports, and from groupware to workflow and document management, etc. Intelligence levels will be increased by using specific techniques (in some cases only software, in others both software and hardware) based on artificial intelligence, recognition systems and virtual realities.

Security is becoming increasingly crucial (particularly for electronic commerce), and a number of innovations have been introduced and are now being standardised.

6.1. ICT security

The progressive development of universal electronic connectivity and the increasing dependence of almost all human activities on ICT systems and managed information have led to a growing awareness of the need for ICT security. The increasingly widespread use of the Internet is extending concerns about break-ins and breakdowns within a hostile world of Web hacking, virus propagation, "spam" electronic mails, spoofs, denial-of-service attacks, and so on. This is changing the risks and nature of possible attacks and, consequently, security needs; as a result, ever greater efforts are being made to find innovative solutions.

ICT security can be defined as a combination of confidentiality (the prevention of unauthorised information disclosure), integrity (the prevention of unauthorised information modification) and availability (the prevention of the unauthorised withholding of information or resources). The OSI Security Architecture (IS7498-2) defines the services that can be provided within the framework of the OSI Reference Model, as well as the mechanisms for implementing them. This standard identifies security services as entity authentication, access control, information confidentiality and integrity and non-repudiation (i.e. protection against any attempt by senders/recipients to deny sending/receiving data or its contents). These are "specific services" that can be selected by users, and added to some of the intrinsic and "pervasive" services of the entire open system, including trusted functionality, security labelling, event detection, security audit-trail and security recovery. All ICT security services are deployed by means of security mechanisms such as encipherment, digital signature, access control, data integrity, authentication exchange, traffic padding, routing control and notarisation.

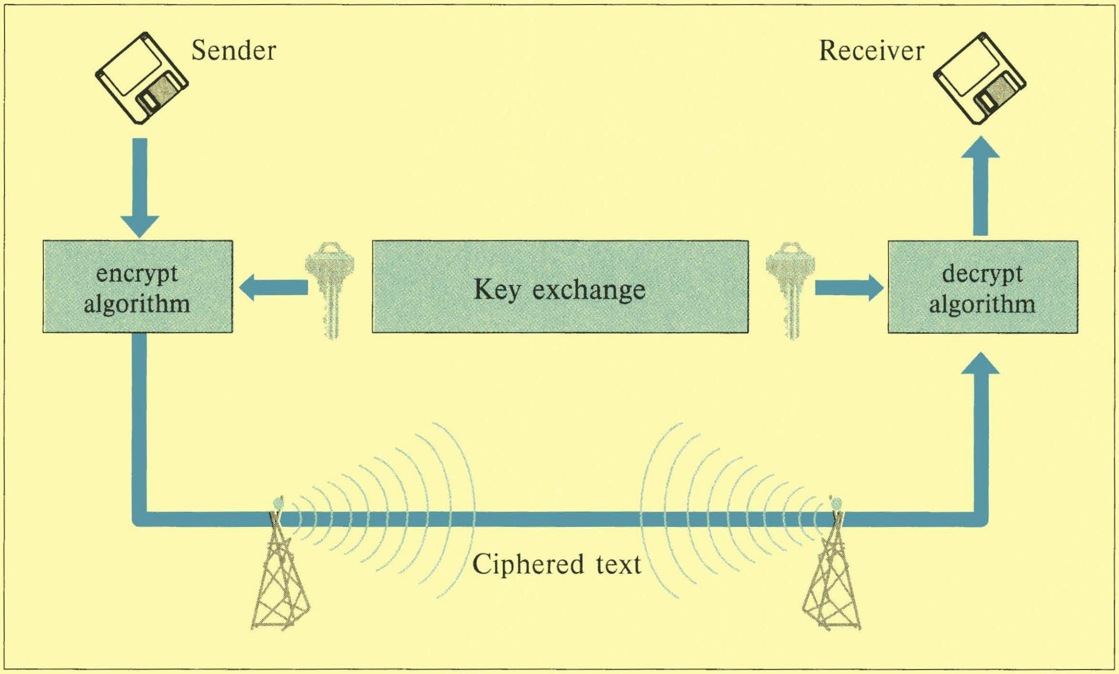


Figure 21
A logic scheme of symmetric cryptography

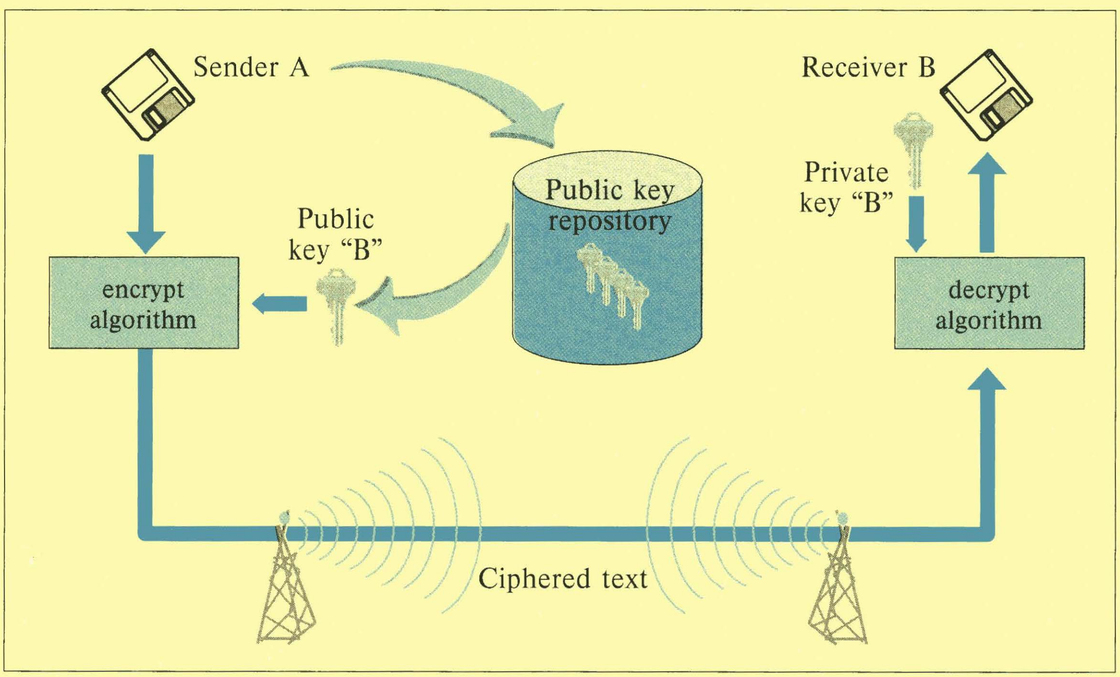


Figure 22
A logic scheme of asymmetric cryptography

This conceptual framework is the basis for all of the emerging security systems, from firewalls to VPNs, from digital signature to new cryptographic algorithms, from security tokens to smart cards, from single sign-on to biometric technologies. A number of new standardisation initiatives are currently under way, including framework, policy and evaluation criteria, new public-key algorithms, new security APIs and protocols, key management, Public Key Infrastructures (PKIs), and specifications.

For an updated view of ICT security standards, refer to [http://www2.echo.lu/oii/en/secure.html] and to [http://www.rsa.com]. The latest innovative areas include PKI and certificate management, with the standard proposals of OpenPGP, PKIX, Internet Public Key Infrastructure, and SPKI, Simple Public Key Certificate ([http://www.rfc-editor.org/rfc.html] for the Internet Requests for Comment and [http://www.ietf.org/ID.html] for the drafts).

6.1.1. Encryption mechanisms and hash functions

The strength of a cryptographic system depends on the key length and the computational work required to break a cipher. Strong crypto systems require keys of at least 128 bits for symmetric and 1,024 bits for asymmetric algorithms. The USA Government currently allows the free export only of weak systems, with keys of 40-56 bits for symmetric and 512 bits for asymmetric algorithms [http://www.bxa.doc.gov/]. The EU recommendation approved in May '98 recommends strong cryptography, and will be operative from 2001.

Symmetric algorithms must know the same key used by the two partners (see *Figure 21*). The various algorithms for symmetric encryption include:

- Data Encryption Standard (DES), the most widely used standard with a 56-bit key; it is now considered inadequate because of the possibility of a deep-crack with current technology, and the standard key length will probably be increased to 90 bits or more;
- triple DES encrypts three times with two different symmetric keys;
- the International Data Encryption Algorithm (IDEA) uses a 128-bit key and 8 rounds;
- RC2 is a faster algorithm than DES and designed as a "drop-in" replacement for it;
- RC4 is variable key-size stream cipher with byte-oriented operations that is based on the use of random permutations;
- RC5 is a fast block cipher with a variable block size (32, 64 and 128 bits), a variable key size (from 0 to 2,048 bits) and a variable number of rounds (from 0 to 255);
- CAST-128 (RFC 2144) uses a variable key size ranging from 40 to 128 bits;
- Blowfish is fast, simple and compact (it can run using less than 5 K of memory), and has a variable key size of up to 448 bits.

Asymmetric algorithms use two different keys (see *Figure 22*) for encryption and decryption, neither of which can be obtained from the other.

Every user has two keys: the first is "private" and known only to him/her; the second is "public" and known to all of his/her possible partners. In addition to the basic confidentiality feature, sender and/or recipient authentication can also be achieved because messages encrypted using a public key can only be decrypted by the holder of the corresponding secret key (recipient authentication), and sender authentication is guaranteed by encrypting the whole or part of a message using the secret key (by means of the corresponding public key, the recipient can check that the sender is the one presumed). The best known asymmetric algorithm is the RSA (Rivest, Shamir, Adelman);

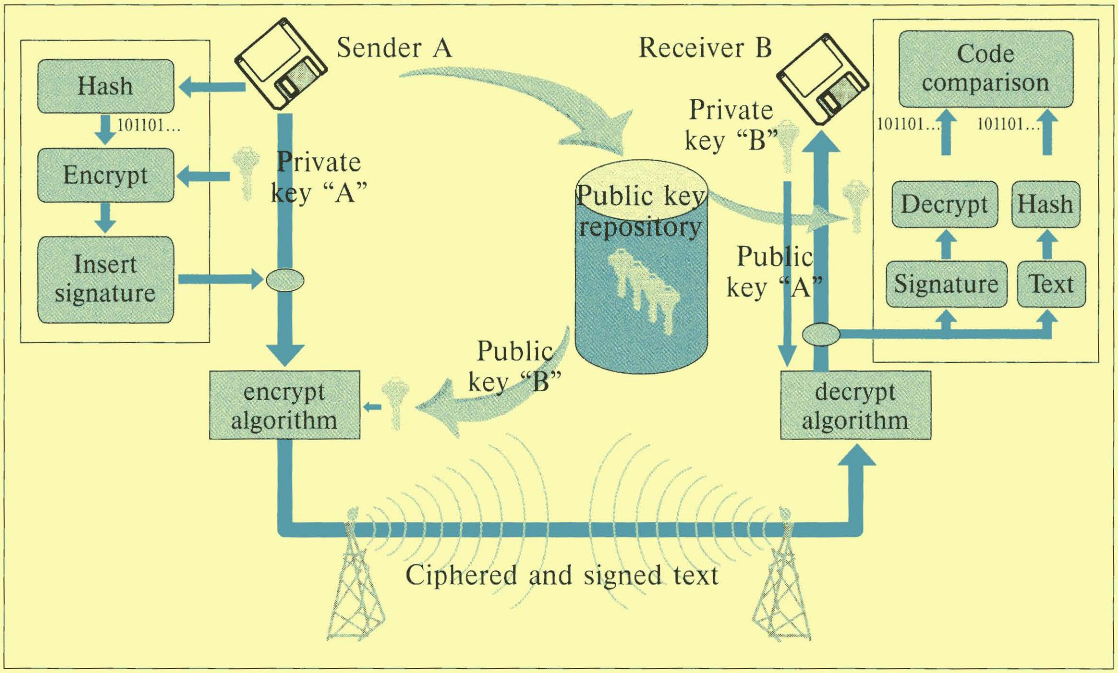


Figure 23
A logic scheme of interlocutor authentication and digital signature

other public key algorithms include those of Deffie-Hellman and El Gamal. Various standardisation activities are aggregating different optional algorithms, techniques and procedures in order to provide security solutions for specific environments and applications, such as the financial industry. Examples are the PKCS, Public-Key Cryptography Standards (ISO/IEC 11770) [http://www.rsa.com] and IEEE P1363 (Standard Specifications For Public Key Cryptography) [http://grouper.ieee.org/groups/1363/], which is still under development.

It is worth noting that, from the point of view of resisting cryptanalysis, public-key encryption is no more secure than its conventional symmetric counterpart; furthermore key distribution and management are no simpler.

Elliptic Curve Cryptography (ECC) [http://www.certicom.com/] has recently been introduced as a possible alternative to RSA, because it appears to offer the same security level with shorter keys (and this reduces processing overheads).

At the end of 1997, the National Institute of Standards and Technology (NIST) [http://www.nist.org] issued a request for an Advanced Encryption Standard (AES) based on symmetric algorithms that are as strong or stronger than Triple DES [http://csrc.ncsl.nist.gov/encryption/aes/aes_home.htm.].

6.1.2. Digital signatures and authentication

A user can be identified by referring separately or jointly to what the user knows (i.e., a password), has (i.e., a smart card), and his/her physical and/or behavioural characteristics (i.e., a fingerprint or way of speaking or writing). In the first two cases, the type of identification is "indirect" and implies that the possession or knowledge of objects or information constitutes "proof of identity"; the third includes a number of already marketed products based on "biometric" techniques, such as face recognition, retina, finger or palm/hand scanning, thermal imaging and voiceprints. The use of smart cards equipped with microprocessors aimed at preventing duplication and tampering, associated with encryption-based authentication techniques, provides for "personal identification" especially in commercial and industrial environments.

Authentication is the verification of an entity-claimed identity, normally that of a user, but it could also be of a process or message. Asymmetric public-key algorithms allow the authentication of both interlocutors and the exchanged messages (whose integrity they can also verify), a process that can be provided by means of a *digital signature* (see logic scheme in *Figure 23*), which can be defined as a piece of information based on both the message/document and the signer's private key. A *hash value* concisely represents the longer message or document from which it was computed, and is therefore known as the *message digest,* which can be thought of as a "digital fingerprint" of the larger document. Examples of well-known hash functions are MD2, MD5 (RFC 1321) and SHA (Secure Hash Algorithm).

The Digital Signature Standard (DSS) has been published by NIST as a USA standard (FIPS PUB 186) [http://www.nist.gov/]: it uses SHA and Digital Signature Algorithm (DSA), a new public-key technique based on algorithms which, unlike RSA, can only be used for signatures, and not for encryption or key management.

Regardless of the cryptography system used, what kind of information does the receiver have or control that really allows sender authentication, and what is the connection between a private key and whoever claims to be its owner? The answer is an Authentication Certificate (AC), a digital document attesting the binding of a public key to an individual or other entity that makes it possible to verify the claim that a given public key does in fact belong to a specific individual.

A Certification Authority (CA) is any trusted central administration willing to vouch for the identities of those to whom it issues certificates and their association with a given key (a simple example is given in *Figure 24*).

The current reference standards are ISO/IEC 9798, which specifies "Entity authentication mechanisms" [http://www.iso.ch/cate] and allows the use of different algorithms, and the ISO/ITU X.509 Version 3 (ISO 9594-8 1997) [ftp://ftp.darmstadt.gmd.de/pub/secude/standards/x509v3/], which refers to RSA for the recommended strong authentication based on public-key cryptography, even if the authentication framework is not dependent on the use of a particular cryptographic algorithm.

X.509 defines the directory authentication process, including public-key authentication, digital signatures, certificates and Certification Revocation Lists (CRLs).

6.1.3. Public Key Infrastructures (PKIs) and Certification Authorities (CAs)

A public-key infrastructure consists of protocols, services and standards supporting public-key cryptography applications. Although defined in various ways, PKIs have the common function of managing public keys, often through the use of a Certification Authority (CA) and Registration Authority (RA). Typical services include key registration, certificate revocation, key selection and trust evaluation (a check as to whether a certificate is valid and what rights are authorised).

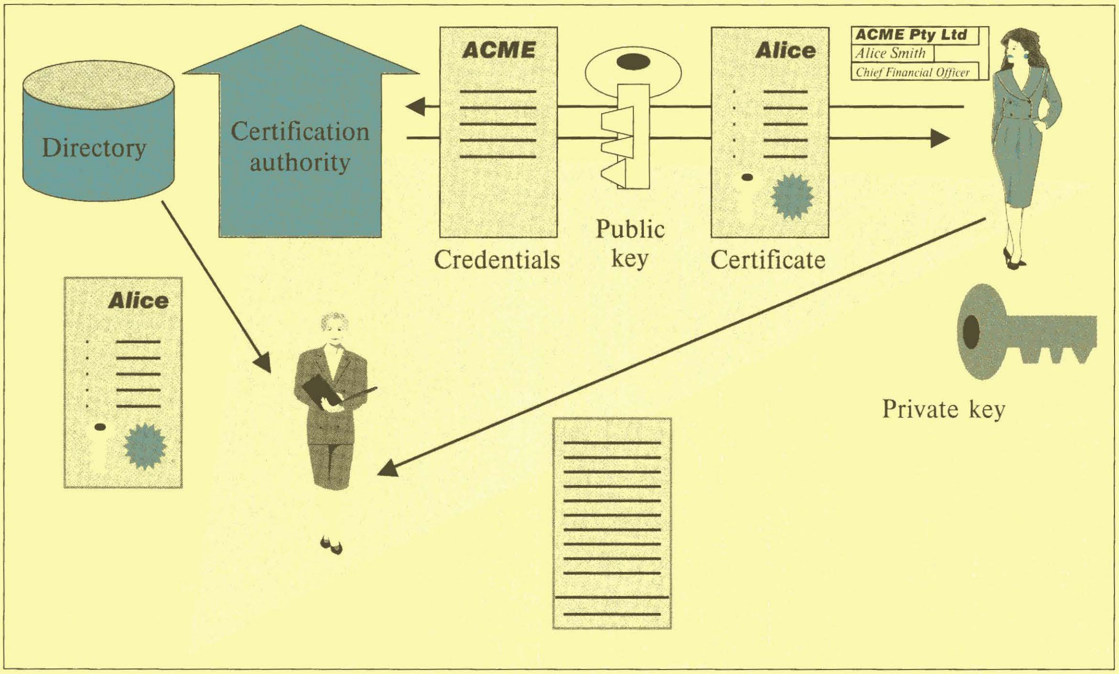


Figure 24
A logic scheme of certificate management

A number of attempts are under way to define a standard PKI: IETF Task Forces are working on PKIX and SPKI and, together with IETF, the Open Group is working on the latest proposals for an HMG PKI [http://www.open-group.org/public/tech/security/pki/cki/] and the draft of "Common PKI Architecture".

The aim of SPKI [http://www.ietf.org/html. charters/spki-charter.html] is to define IETF standards for public-key certificate, associated signature and other formats, as well as key acquisition protocols, within a wider range of Internet applications (including IPSEC protocols, encrypted electronic mail and WWW documents, and payment protocols). SPKI proposes a method for generating secure public-key certificates without the intervention of a certification agency (the keys will include information on who can use the key, what the key can be used for, and how long it is valid). SPKI can import PKIX and PGP certificates.

PKIX is an Internet version of X.509 Version 3, which specifies the format and semantics of X.509 certificates and certificate revocation lists for the Internet. Encoding rules are provided for popular cryptographic algorithms. A comprehensive ASN.1 module is provided for all defined or referenced data structures. SSL (Secure Socket Layer) and S/Mime (Secure Mime) are draft Internet standards for transport and file/message security supporting PKIX certificates.

Open PGP (the public specification of Pretty Good Privacy) is one of the most widely used services for the provision of confidentiality and authentication of electronic mails and file storage. The PGP package, documentation and source code are freely available via Internet [http://www.pgpi.com/]. PGP application is independent of operating systems and can run on different platforms. It combines the use of symmetric and asymmetric cryptographic algorithms (e.g. IDEA with RSA) and uses DSS/SHA or RSA/SHA for digital signatures.

6.2. The convergence of cyberworld and televisionworld

One of the key frontiers for the current convergence of media and ICT techniques for business and domestic environments is the technical and functional integration of the cyberworld (particularly Internet Webs and protocol piles) with the media broadcasting world. As discussed in section 3.4., the various products that will be put on the market are based on different logics and standards.

The hyper-multimedia environments, as reported by EITO 98, have several standards, referring to the contemporaneous mixed use of different media, and how they can be correlated, synchronised and presented. Among them, HyperODA, Hypermedia Extensions to the Open Document Architecture [http://www2.echo.lu/oii/en/moving.html#HyperODA], OMF, Open Media Framework [http://www.omfi.org], HyTime, Hypermedia Time, based on Structuring Language defined by ISO for the definition of hypermedia documents via SGML, and DAVIC, the architectural standard for operational integration of systems working in different domains, with digital audio-visual applications and services of broadcast and interactive type, considering all the information chain components [http://www2.echo.lu/oii/en/moving.html#DAVIC]. DAVIC has been submitted for fast-track approval as an ISO standard in 1998 under ISO's Publicly Available Specification (PAS) procedures, in order to be widely adopted within industry before becoming an approved ISO standard in 1999.

Table 11 shows some of the multimedia standards currently deployed, and outlines the new emerging ones.

From an architectural point of view, *Figure 25* depicts the possible general architecture for converging Web/TV services. The composition layer refers to the languages in which the service's presentation to the user is specified. It includes aspects like synchronisation and user interaction that can be provided by D-HTML, CSS, SMIL and MHEG. The representation layer concerns the encoding of the (media) objects of which the presentation is composed, using techniques like MPEG, AVI, WAV. The transport layer encompasses the access and transport protocols to deliver the content, being the MPEG and IP suites. The vertical layer could be thought of as encompassing database-related issues like naming (namespaces, URIs) and indexing (search, retrieval, alternates, languages).

In the following two meaningful emerging standards, MPEG-4 and MHEG, are considered.

6.2.1. MPEG-4

MPEG-4 is an ISO/IEC standard being developed by MPEG (Moving Picture Experts Group), which also developed the MPEG-1 and MPEG-2 standards that made possible the use of interactive video on CD-ROM and Digital Television. MPEG-4 (whose formal ISO/IEC designation will be ISO/IEC 14496) was approved as an International Standard in December 1998: for details, refer to [http://www.cselt.it/] and [http://www.iso.ch].

MPEG-1 is a 5-part standard for the storage and retrieval of moving pictures and audio on storage media, officially designated as ISO/IEC 11172.

MPEG-2 is a 9-part standard for digital television, officially designated as ISO/IEC 13818.

MPEG-4 is a new multimedia standard designed for use in broadcast, interactive and conversational environments. Its structure allows MPEG-4 to be used in television and Web environments not just one after the other, but also facilitates the integration of content coming from both channels in the same multimedia "scene". Its strong points are inherited from the

Table 11
Some of current in operation and emerging multimedia standards

Name	Standard entity	Emerging	Text	Audio	Image	Video	Comments
AC3	Proprietary (USA)			x			
ADMPC, Adaptive Differential Pulse Code Modulation				x			
AIFF, Audio Interchange File Format	Proprietary			x			
AVI, Audio Video Interleave	Proprietary			x		x	
CGRM, Computer Graphic Reference Model	ISO				x		Vector graphic
Hyper ODA	ISO	x	x	x	x	x	
HyTime	ISO	x	x	x	x	x	
IIP, Internet Imaging Protocol	IETF, Proprietary				x		
JBIG: Joint Bilevel Image Group	ISO, ITU				x		Raster graphic
MCI, Media Control Interface	Proprietary						
MHEG	ISO	x	x	x	x	x	
MHP, Multimedia Home Platform	ETSI		x	x	x	x	Architectural framework
MIME	IETF		x	x	x	x	
MMCF Reference Architecture	MMCF		x	x	x	x	Architectural framework
M-JPEG	JPEG						
MPEG-1	ISO	x	x	x		x	
MPEG-2	ISO	x	x	x		x	
MPEG-4	ISO	x	x	x		x	
PNG: Portable Network Graphics	W3C				x		
JBIG: Joint Bilevel Image Group	ISO, ITU-C					x	
JPEG + SPIFF: Joint Photographic Experts Group standard and Still Picture Interchange File Format	ISO, ITU-C		x	x		x	
QuickTime	Proprietary		x	x		x	
SMIL, Synchronised Multimedia Integration Language	W3C	x	x	x		x	
DAVIC	Davic	x	x	x		x	Architectural framework
VEMMI, Videotex Enchanced Man/Machine Interface	ETSI, IETF		x	x	x	x	
Video for Windows	Proprietary					x	
SMDL, Standard Music Description Language	ISO	x		x			
VRML, Virtual Reality Modelling Language	ISO, VAG	x	x	x		x	
H.120	ITU-C					x	

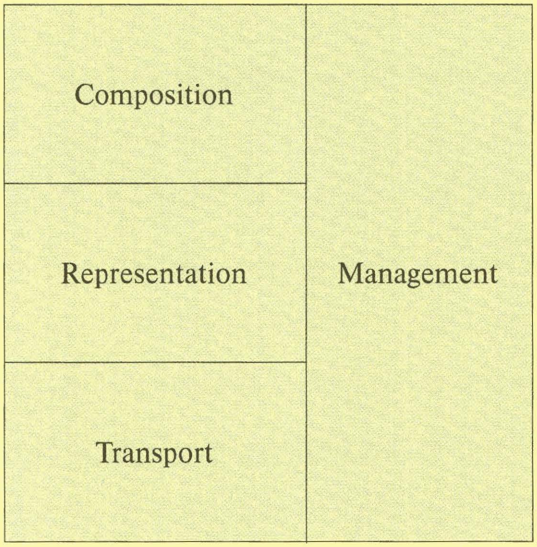


Figure 25
General scheme of an integrated Web/TV architecture

successful MPEG-1 and -2 standards (broadcast-grade synchronisation and the choice of on-line/off-line use) and VRML (the ability to create content using a "scene description").

MPEG-4 adds to MPEG-1 and -2:

- the integration of natural and synthetic content in the form of "objects", which may represent "recorded" entities (a person, a chair) or synthesized material (a voice, a face, an animated 3-D model);
- support for 2-D and 3-D content;
- support for various types of interactivity;
- coding at very low (2 Kbit/s for speech, 5 Kbit/s for video) and very high rates (5 Mbit for transparent quality Video, 64 Kbit/s per channel for CD quality Audio);
- support for the management and protection of intellectual property.

MPEG-4 adds to VRML:

- native support for natural content and real-time streamed content, using URLs;
- efficient representation of scene descriptions.

MPEG-4 preserves compatibility with the major existing standards: MPEG-1, MPEG-2, ITU-T H.263, and VRML. MPEG-4 Version 1 is virtually ready, and the backward compatible MPEG-4 Version 2 (which will extend the capabilities of the standard) has been finalised by the end of 1998.

Audiovisual scenes are composed of several media objects organised in a hierarchical fashion: primitive media objects, such as still images (e.g. a fixed background), video objects (e.g. a talking person – without the background), audio objects (e.g. the voice associated with that person), etc.

MPEG standardises a number of such primitive media objects capable of representing both natural and synthetic content, which may be either 2- or 3-dimensional. Furthermore, it also defines the coded representation of objects such as text and graphics, talking synthetic heads and the associated text used to synthesize the speech and animate the head, and synthetic sound.

Figure 26 shows the way in which an MPEG-4 audiovisual scene is described as being composed of individual objects, in which compound media objects group primitive media objects together: the primitive media objects correspond to leaves in the descriptive tree, whereas compound media objects encompass entire sub-trees. Note that the visual object corresponding to the talking person and the corresponding voice are tied together to form a new compound media object that contains both the aural and visual components.

MPEG has defined "Profiles" that group its capabilities into subsets that are useful for simple applications, richer Web content and more powerful set-top boxes.

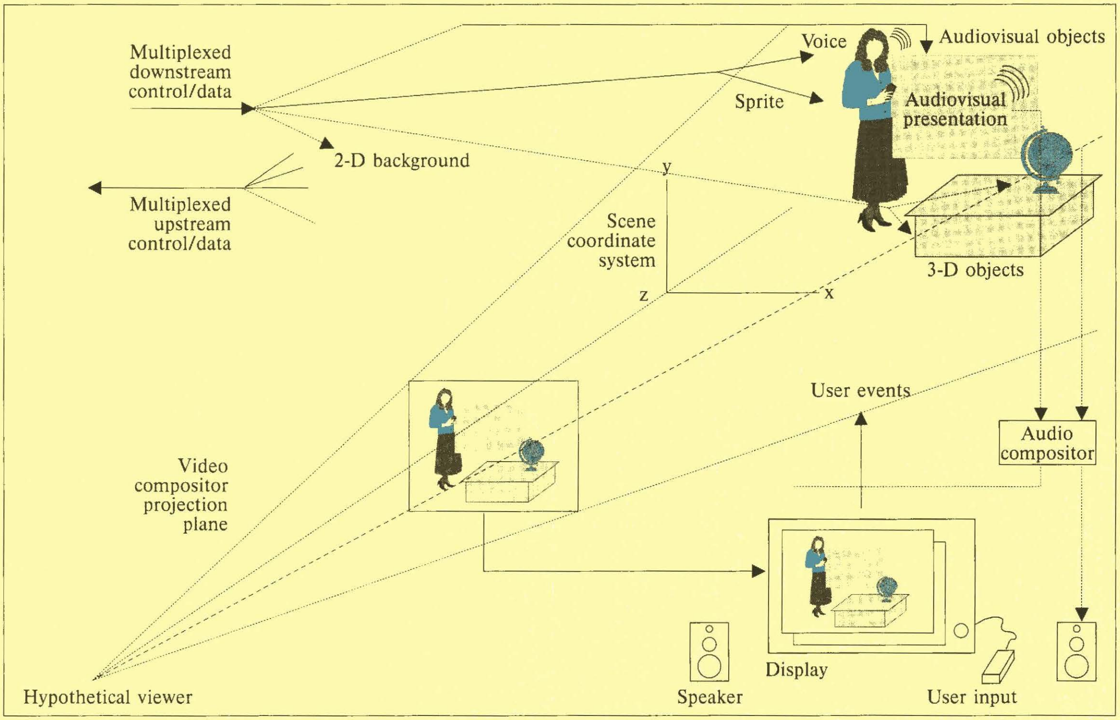


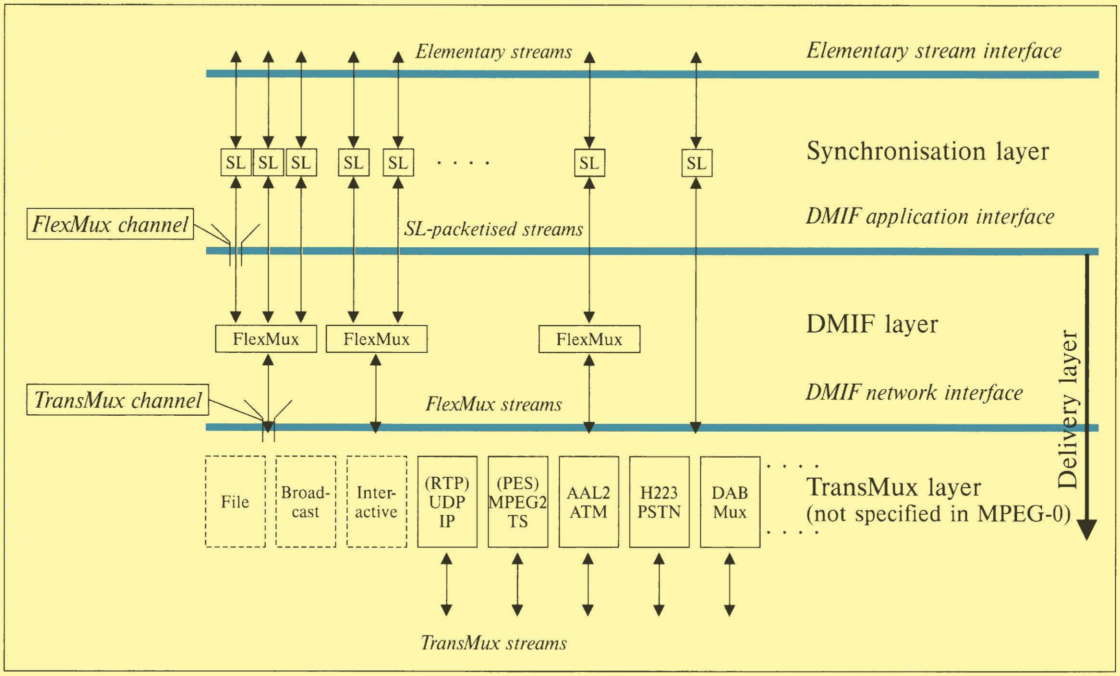
Figure 26
An example of an MPEG-4 audio-visual scene

Source: Cselt

The following types of synthetic content are supported:

- Structured Audio (SA), which specifies an extremely bandwidth-efficient representation for creating rich synthetic audio content. It is harmonised with MIDI (which it includes as a subset) and also contains "Score Language" and "Orchestra Language".
- Facial animation, which can be used in harmony with the MPEG-4 Text-to-Speech Interface in order to transmit the text and attributes necessary for correct reproduction by a (proprietary) Text-to-Speech system. This includes things like language, gender, prosody, etc. MPEG is currently working on body animation, which will be added in Version 2.
- 2-D meshes with mapped-on textures. Version 2 will add 3-D meshes.
- Scalable textures, with support for view-dependent scalability.
- VRML-like content (lines, circles, boxes, text, etc.).
- Media objects may rely on streaming data conveyed in one or more elementary streams, with all of the streams associated with one media object being identified by an object descriptor.
- Each stream is itself characterised by a set of descriptors conveying configuration information: e.g. to determine the required decoder resources and the precision of the encoded timing information. Furthermore, the descriptors may convey hints as to the Quality of Service (QoS) it requires for transmission (e.g. maximum bit rate, bit error rate, priority, etc.).

Figure 27
The MPEG-4 system layer model



Source: Cselt

- The elementary streams are synchronised by means of the time stamping of individual access units within them. These are identified and time stamped by the synchronisation layer which, regardless of the media type, enables the synchronisation of the identification of the access units (e.g. video or audio frames, scene description commands) in elementary streams and the recovery of the time base of the media object or scene description. The syntax of this layer can be configured in a large number of ways, thus allowing it to be used in a wide range of systems.
- The synchronised delivery of streaming information is specified by the synchronisation layer and a delivery layer containing a two-layer multiplexer, as shown in *Figure 27.*

In general, users observe a scene made up on the basis of the design of the scene's author; however, depending on the degree of freedom allowed by the author, they may also be able to interact with the scene. The operations a user may be allowed to perform include changing the viewing/listening point (i.e. by navigating through a scene); dragging objects to a different position; triggering a cascade of events by clicking on a specific object (i.e. by starting or stopping a video stream); and selecting the desired language when multiple language tracks are available. In addition, more complex kinds of behaviour can be triggered (e.g. a virtual phone rings, the user answers and a communication link is established).

As shown in *Figure 27,* the streams coming from the network (or a storage device) as TransMux Streams are demultiplexed into FlexMux Streams and passed to appropriate FlexMux

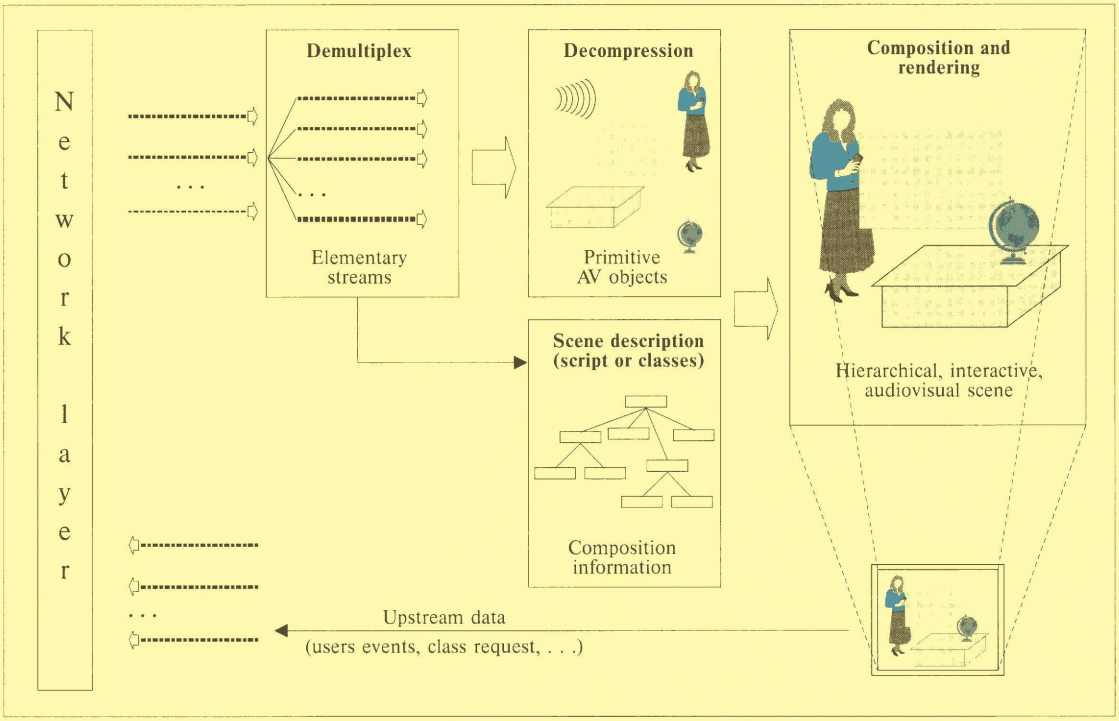


Figure 28
Major components of an MPEG-4 terminal (receiver side)

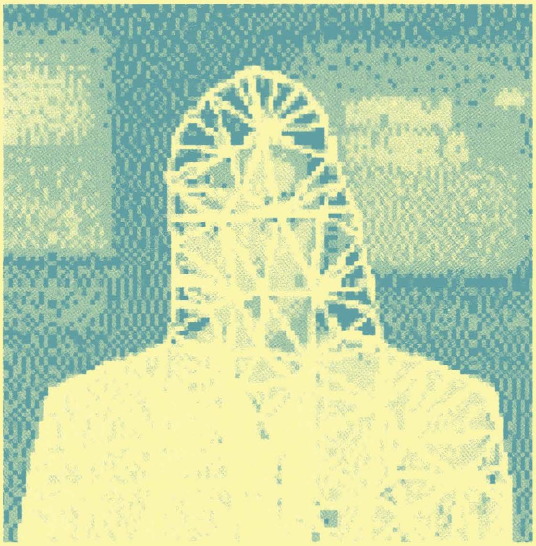
Source: Cselt

demultiplexers that retrieve the Elementary Streams (ESs), which are parsed and passed on to the appropriate decoders. Decoding recovers the data incorporated in an AV object from its encoded form and carries out the operations necessary to reconstruct the original object ready for rendering on the appropriate device. The Delivery Multimedia Integration Framework (DMIF) is a session protocol for the management of multimedia streaming over generic delivery technologies which, in principle, is similar to FTP (File Transfer Protocol): the only (but essential) difference is that FTP returns data, whereas DMIF returns pointers as to where the (streamed) data can be found. Unlike FTP, DMIF is both a framework and a protocol, with the provided functionality being expressed by a DMIF-Application Interface (DAI) and translated into protocol messages. These protocol messages may differ according to the network on which they operate. Quality of Service is also considered in the DMIF design, and the DAI allows DMIF users to specify the requirements for the desired stream.

An additional interface – the DMIF-Network Interface (DNI) – is introduced to highlight what kind of information DMIF peers need to exchange, and a further module ("Signalling mapping" in the figure) maps the DNI primitives into the signalling messages used by the specific Network.

MPEG-4 standardises natural audio coding at bit rates ranging from 2 kbit/s to 64 kbit/s and more, with the presence of the MPEG-2 AAC standard inside the MPEG-4 tool set providing for the general compression of audio in the upper bit rate range. In order to achieve the highest audio quality within the full range of bit

Figure 29
2-D mesh modelling of the "Akiyo" video object



Source: Cselt

rates, and at the same time provide the extra functionalities, three types of coding structures have been incorporated into the standard:

- Parametric coding techniques cover the lowest bit rate range: i.e. 2-4 kbps for speech with an 8 kHz sampling frequency, and 4-16 kbps for audio with an 8 or 16 kHz sampling frequency.
- Speech coding at medium bit rates of about 6-24 kbps uses Code Excited Linear Predictive (CELP) coding techniques. In this region, 8 and 16 kHz sampling frequencies are respectively used to support narrow- and wideband speech.
- For bit rates starting below 16 kbps, time-to-frequency (T/F) coding techniques (the TwinVQ and AAC codecs) are applied; the audio signals in this region typically have sampling frequencies starting at 8 kHz.

MPG-4 provides a Text-To-Speech (TTS) decoder, but more general sounds including music may be synthesized. TTS coder bit rates range from 200 bit/s to 1.2 Kbps, which allows texts or texts with prosodic parameters (pitch contour, phoneme duration, and so on) to be used as inputs to generate intelligible synthetic speech. MPEG-4 provides a standardised interface for the operation of a Text-To-Speech coder (TTSI = Text-To-Speech Interface).

Structured Audio tools decode input data and produce output sounds, making use of a special synthesis language called SAOL (Structured Audio Orchestra Language), which is a standardised part of MPEG-4. This language is used to define an "orchestra" made up of the "instruments" that create and process control data. The MIDI protocol can also be used to control the orchestra.

Visual objects can be of natural or synthetic origin, and the visual part of the MPEG-4 standard provides solutions in the form of tools and algorithms for the efficient compression of images and video.

Synthetic objects form a subset of the larger class of computer graphics, and include parametric descriptions of the human face and body, as well as face and body animation streams (body animation in Version 2).

Facial shapes, textures and expressions are generally controlled by the bit stream containing instances of Facial Definition Parameter (FDP) and/or Facial Animation Parameter (FAP) sets. Upon construction, the face object contains a generic face with a neutral expression that can already be rendered; but it is also immediately capable of receiving the animation parameters from the bitstream that will animate the face in terms of expressions, speech, etc. If definition parameters are received, they are used to transform the generic face into a particular face determined by its shape and (optionally) texture. If so desired, a complete face model can be downloaded via the FDP set as a scene graph for insertion in the face node.

A 2-D mesh represents the tessellation (or partition) of a 2-D planar region into polygonal patches; MPEG-4 considers only triangular meshes where the patches are triangles. An example of a 2-D mesh is given in *Figure 29*.

6.2.2. MHEG

The Multimedia Hypermedia Experts Group (MHEG) [http://www.mhegcentre.com/] is an ISO/IEC International Standard (ISO/IEC 13522), which is also published as a set of recommendations (T.17x series), that specifies a coded representation of final-form multimedia/hypermedia information objects for their interchange by any means of interchange, from storage devices to telecommunication and broadcast networks. These objects define the structure of multimedia/hypermedia presentations in a system-independent way.

MHEG is currently arousing enormous interest on the part of most of the major actors operating in the interactive TV market: MHEG-5 was adopted by the UK DTG (D-Mux Group) for digital terrestrial TV services; MHEG-5 and -6 have been selected by DAVIC within the context of the Multimedia Home Platform (MHP), and by DVB.

The MHEG specification is structured in parts.

MHEG-1 defines multimedia objects, their behaviour, the actions that can be applied to them, and their interchange representation in ASN.1 *(Abstract Syntax Notation One),* which allows MHEG interpreters to share MHEG objects. MHEG-1 describes a model for the creation and representation of objects, but is not interested in the execution of multimedia presentations. Its purpose is the specification of media object representation and a mechanism for the interchange of media files.

MHEG-2 was intended to define a SGML-based encoding specification for the framework defined by MHEG-1, but it was cancelled before finalisation.

MHEG-3 defines an executable code dedicated to a virtual machine *(Script Interchange Representation – SIR),* which can be considered a scripting language.

MHEG-4 defines the ISO official procedure for assigning identifiers to the content formats used by other MHEG parts.

MHEG-5 allows the development of an MHEG interpreter that requires few resources. It provides an interface with an external code, such as a script interpreter, and has the aim of supporting the distribution of interactive multimedia/hypermedia applications in a client/server architecture across platforms of different types. The applications reside on the server, and their various parts are downloaded to the client as they are needed. The MHEG-5 interpreter resides on the client, and is responsible for interpreting the application parts to present to the user, and for handling local user interactions. This "light" interpreter is meant to fit in a "set-top box", and has therefore been considered by MHP.

MHEG-6 extends MHEG-5 functions by adding features for the manipulation of MHEG-5 objects, computations (including handling and control structure variables), data acquisition, and external device control access to external data and run-time services. It uses Java byte-code representation as an interchange format, the Java Virtual Machine to interpret this format, and a basic set of Java APIs to provide access to basic platform functionality. A programming interface enables programmes to have access to MHEG-5 objects and interpreter services. MHEG-6 is mainly intended to support the distribution of interactive retrieval (client/server) applications running on limited-resource, asymmetric-channel set-top boxes, audio-visual streams on the downward channel.

MHEG-7, which is still under development, will specify the interoperability and conformance testing of MHEG-5 interpreters. For this purpose, it will define a test suite that can be used to test the conformance of an MHEG-5 engine to a specific application domain. It will also define a format for test cases that can be used to extend the test suite or the extensions required by an application domain.


HANNOVER

Part Two

The E-commerce market in Europe

This paper is the first edition of the E-commerce Observatory to be featured in the EITO. It has been prepared by Romtec in close co-operation with the EITO Task Force and the Directorate-General of Industry (DG III) of the European Commission.

1. Explosive growth now approaching critical mass

In June 1998, EITO commissioned Romtec to survey the status of E-commerce in Europe. The survey was conducted with 570 companies, across the EU and Norway and eight industry sectors, and its objective was to assess the current penetration of E-commerce as well as its rate of adoption over the next five years. The survey probed the drivers for E-commerce adoption, and, in particular, the motivating factors that figured in organisations' business cases for E-commerce. The findings relating to this survey which are presented in this paper are the results of a random sample. Please see the "survey methodology" in the Annex for full sampling details.

E-commerce activity is exploding in Europe*, with the market near to critical mass in key areas of E-commerce, and within certain countries and sectors. At critical mass point, E-commerce will sweep across the rest of the market, becoming normal practice for every organisation that wishes to remain competitive on a regional, national or global stage.

E-commerce is on the threshold of becoming a major influence on new and more competitive business models across Europe. The major characteristics of this phenomenon may be summarised as follows:

- There was a remarkable growth in E-commerce infrastructure and services between 1996 and 1998:

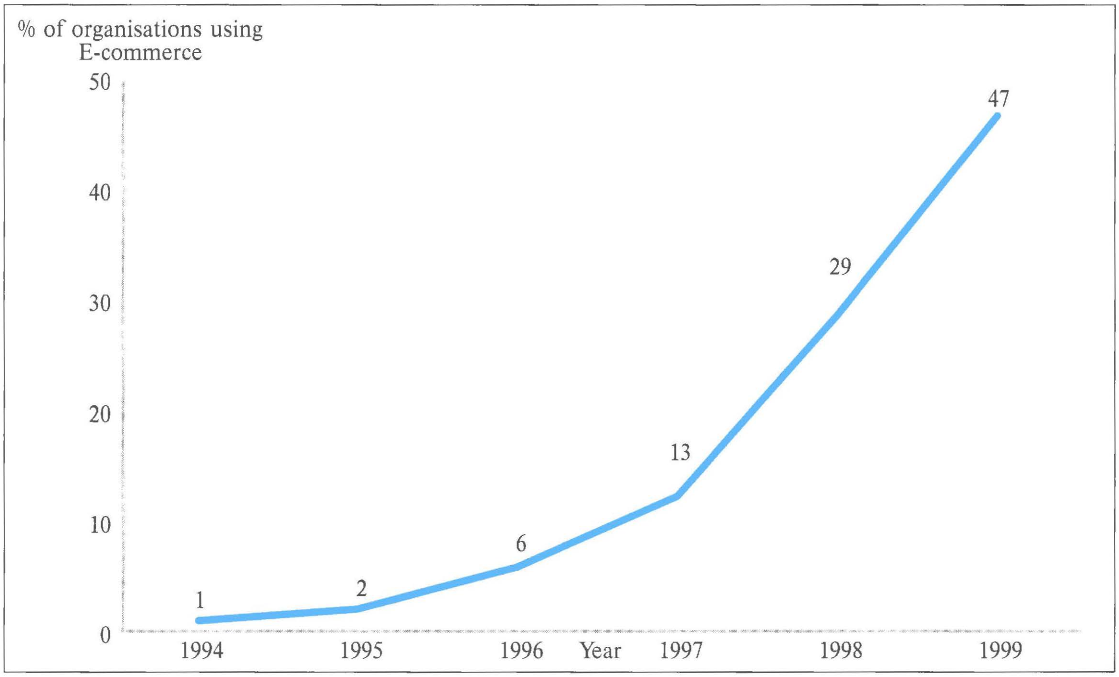
  i) of those European businesses surveyed which are connected to the Internet, 82% actually connected between 1996-1998 (see section 3.2.1.);

  ii) of those businesses which have an Intranet and those which have an Extranet, approximately four in five installed their Intranet (80%)/Extranet (77%) between 1996 and 1998 (see section 3.3.1.).
- There is an explosion in the number of E-commerce applications being put in place. As of the end of 1998, 29% of European businesses will be using Internet-based E-commerce applications** - up from just 6% in 1996 - and, by the end of 1999, just under a half (47%) of European businesses will be using Internet-based E-commerce applications (see *Figure 1*).
- The current penetration of E-commerce marketing applications amongst E-commerce current/planned users (30%) is high, whilst 17% of such businesses currently use E-commerce sales applications and 13% use E-commerce purchasing applications. From an end-user perspective, critical mass (defined as 50% penetration) occurs when an E-commerce application becomes the norm. This is expected to be the case for the majority of businesses before the end of 2001 (i.e. within three years) for each of marketing, sales, post-sales and purchasing applications (see section 4.4.).

** Note that E-commerce applications do not necessarily involve the execution of financial transactions (transfer of funds) across electronic networks.

* For the purposes of this paper the terms "Europe" and "European" refer to the European Union and Norway. When the terms are quoted from external sources of information, the reader should refer to that source of information for the exact definition of terms.

Figure 1
Internet-based E-commerce penetration, 1994-1999



Note 1: Figures are for end of year; figures for 1998 and 1999 are projections
Note 2: Figures in subsequent graphs show percentage of organisations using Internet-based E-commerce as of September 1998
Base: All organisations (416 respondents)

Unless otherwise stated, the source of all figures in this paper is Romtec, 1998.

- At a country and sector level, there are significant differences in E-commerce application usage. Scandinavia leads, and is expected to continue to lead E-commerce application take-up. Germany is set to overtake the UK, which is falling back in its adoption rate, while the Mediterranean countries, Spain/Portugal and Italy, are fast catching up with the leaders and will have a similar adoption profile by the beginning of the millennium. Adoption in France is slower. Across industries, business services and utilities are the most dynamic in terms of E-commerce adoption, with the finance sector lagging the trend.
- At the moment, most organisations are responding defensively, rather than strategically to E-commerce. Competition is a substantial motivating factor, particularly for "second-wave" companies with plans to implement E-commerce.
- E-commerce is seen as an "add-on", rather than as a replacement for other market channels or business processes. Low expectations of hard benefits from E-commerce mean that companies are not yet re-engineering business processes and models to meet the new opportunities and challenges that E-commerce brings. Most organisations are adopting E-commerce without demanding a strong business case for it; indeed, 65% of businesses require a 10% or less increase in sales revenue to feel that E-commerce adoption is justified (see *Figure 2*).
- Early adopters, particularly in industry sectors serving consumer markets, indicate that their E-commerce experience to date has not yet lived up to their expectations. While bottom line benefits, such as reduced costs, were rated as less important than enhancing Quality of Service to customers, and greater flexibility, the lack of a quantifiable return on investment is of concern to businesses.

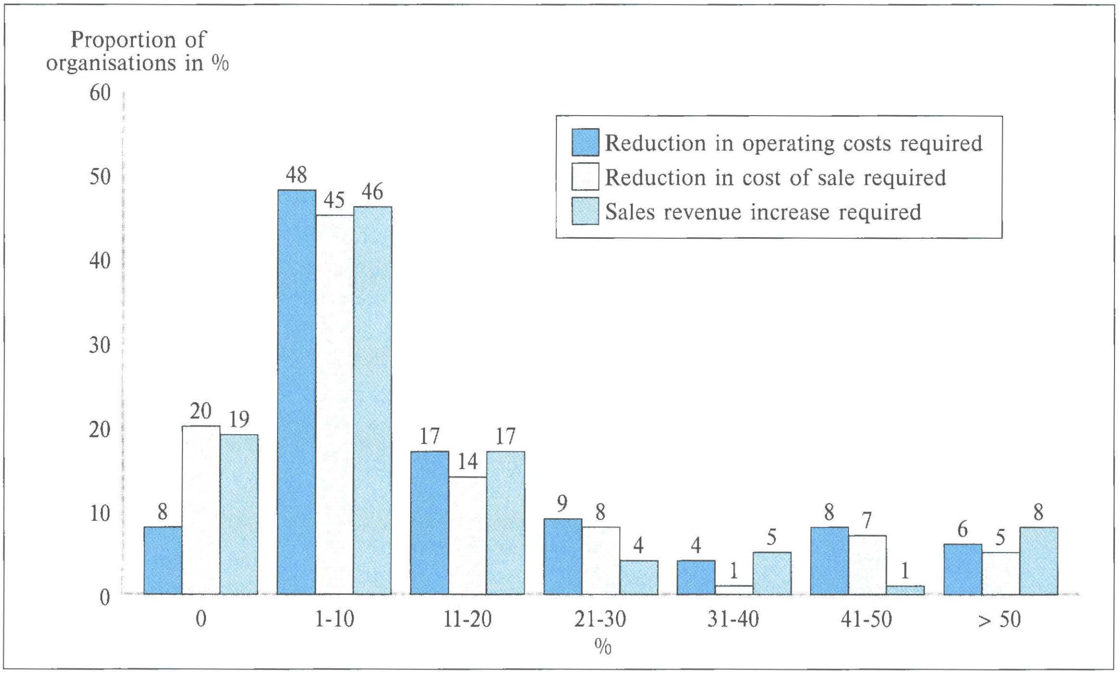


Figure 2
Cost reduction/revenue increase required to justify E-commerce

Base: E-commerce users/planned users (178, 182, 160 respondents)

- Rapid infrastructure and E-commerce applications growth are inadequate indicators of real E-commerce capability in the market. The survey found that indifference ("wait and see") is the biggest barrier to further uptake of E-commerce. This may only be dispelled by hard evidence that E-commerce is effective and delivers real business benefit.

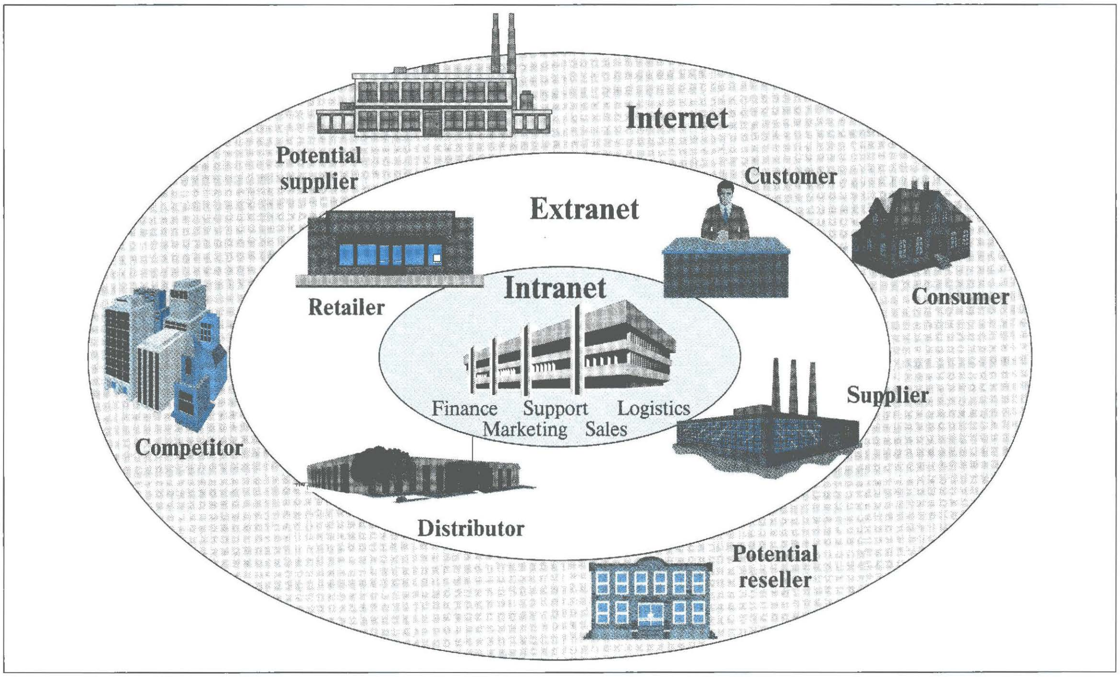
IDC[1] forecasts that Western European[2] revenues from Internet/E-commerce will rise from ECU 900 million in 1997 to ECU 26 billion in 2001. While investment in E-commerce does not seem to have been affected by EMU and Year 2000 issues, business change programmes to leverage the benefits of E-commerce may well be delayed until early in the millennium, when the impact of both issues begins to fall away. Security is another area which needs to be addressed, in terms of changing business and consumer perceptions about the security of E-commerce transactions. Failure to do so will hold back adoption of transactional applications, such as sales, purchasing and post-sales.

It is clear from the survey that E-commerce over the Internet is rapidly being accepted as a significant way in which most organisations will conduct business within the next two to five years. The speed at which acceptance is taking place is also striking, with huge shifts in adoption patterns in sectoral and country markets taking place very rapidly as awareness and competition builds. The key challenge remains to persuade organisations to act strategically rather than defensively in response to E-commerce to maximise the business benefits of this revolutionary opportunity.

[1] The Western European Forecast for Internet Usage and Commerce, IDC 1998

[2] IDC defines Western Europe as all EU countries plus Norway and Switzerland.

Figure 3
The Internet and its subsets



2. What is E-commerce?

2.1. Definition of terms

E-commerce is commercial activity conducted over electronic networks, often over the Internet, which lead to the purchase or sale of goods or services.

E-commerce activities are carried out by three main communities: business, consumer and government. The two relationships most often considered are *business to business* and *business to consumer.*

Business-to-business E-commerce

At present, most business-to-business E-commerce is carried out by business partners who are known to one another, across electronic networks known as *Extranets.* For example, a customer may order product electronically from a regular supplier, with the supplier sending invoices electronically in return.

Note: Section 3.4.6. contains an analysis amongst businesses using E-commerce of overall turnover split between business and consumer end-customers.

The term *Extranet* may be used to describe networks of business partners regardless of the underlying network technology in use. However, Extranets are increasingly associated with business-to-business E-commerce over the Internet. At present, most Extranets support continuous relationships between known trading partners, particularly over private networks using established Electronic Data Interchange (EDI) technology. The Romtec survey suggests Internet-based Extranets are supporting a growing number of ad hoc relationships, between business partners which have had no previous business dealings with one another.

Figure 3 shows the relationship between the Internet and its subsets: Extranets and Intranets. An *Intranet* is a company's internal use of Internet technology to connect the various elements of its business organisation: the Intranet is usually the interface between the company and its trading partners across the Extranet. This figure also highlights the current distinction between organisations in the Extranet with which the organisation has a continuous relationship, and those across the Internet, with which its dealings are ad hoc.

Business-to-consumer E-commerce

Business-to-consumer E-commerce is carried out over the public Internet. The French Minitel system is equally a business-to-consumer E-commerce medium, but it is not discussed in this chapter. Business-to-consumer E-commerce allows individual consumers to purchase, pay for and, depending on the form of the purchase, receive goods and services over electronic networks. For example, a consumer may use the Internet to order flowers or a flight, sending their credit card details over the Internet in payment. The Internet also provides an effective way of supporting, monitoring, and building relationships with customers.

2.2. The E-commerce adoption process

The Romtec survey confirms that the adoption process for E-commerce applications is common across all countries, industry sectors, and sizes of site, but the rate of adoption will vary depending on country, sector and site size. However, Romtec found that all countries and sectors have major plans for application adoption in all areas in 1999, with only a small proportion intending to defer installation until after the millennium. The results of Romtec's survey into application adoption are analysed in detail in section 3.4.

The four types of E-commerce applications currently being established across the Internet are:

- marketing (use of the Web for advertising and promotion);
- sales (receiving orders from customers; customer invoicing, collection or payment);
- post-sales (online supply to customers; customer support; customer monitoring and relationship development);
- purchasing (use of the Web to seek suppliers; receiving purchase orders and after-sales support; payment of suppliers).

E-commerce applications have been in place for some 20 years over private EDI networks. Such applications have facilitated back-office functions such as ordering, invoicing and settlement. However, E-commerce applications over the Internet are demonstrating a different pattern of adoption, with greater emphasis on front-office function and interaction with customers. In 1998, the Internet was treated primarily as a marketing channel, and significantly less as a medium for completing transactions.

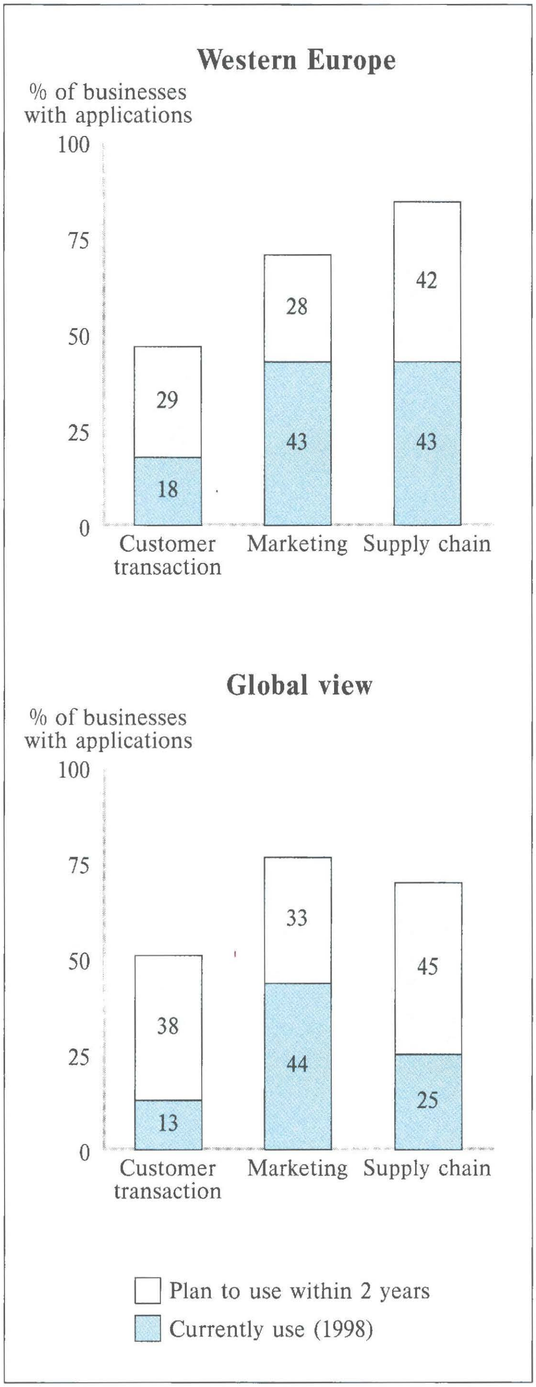
As Romtec's survey shows, marketing applications are typically established first, through web sites which are set up to promote an organisation's products and services. Organisations may pilot the site for several months or years before adding transactional capabilities. In a minority of cases, usually when the Internet is the only sales channel for the organisation, or the channel through which it expects to receive a significant proportion of its revenue, the site will be set up from the start to support transactions, such as purchase ordering and/or payment, and post-sales applications such as electronic delivery and/or electronic delivery tracking.

Supporting research

Other European surveys are also confirming these adoption trends. In 1998, the majority of European web sites were dedicated to marketing applications. A 1998 survey of web sites in the European consumer packaged goods sector, carried out by IBM[1], looked at 65 sites representing over 160 companies and found that only six of these sites supported online sales, of which four were addressed to US consumers only. A survey carried out by Deloitte & Touche[2] Consulting in late 1997 shows that 43% of Western European[3] companies carry out marketing over the Internet, compared to 18% who support transactions with consumers. This

[1] A survey of major CPG web sites, IBM 1998
[2] 1998 Global Survey of Chief Information Executives, Deloitte & Touche Consulting
[3] Western Europe includes all EU and EFTA countries

Figure 4
Growth of Internet applications, 1998-2000



Note: Sample size: + 1,000

Source: Deloitte & Touche Global Survey of CIOs 1998

picture changes, however, in the business-to-business sector, where 43% of the sample claim to be carrying out EDI transactions over the Internet with their business partners.

Deloitte & Touche surveyed just over 100 chief information executives in Western Europe, or 11% of its total survey sample, and found 43% of Western European companies to have marketing applications over the Internet. The IBM web site survey reports that 39% of European companies in the consumer packaged goods segment do not have any web site at all, while Romtec found that the finance, transport/travel and discrete manufacturing sectors had a similar penetration profile.

Figures published by the *Financial Times* suggest that in Europe in 1997, UK companies led in establishing web sites: 30%, or twice the European average, had a site, compared to 12% of French companies and 7% of German companies. In fact, Romtec, in late 1998, found the UK only just ahead of Germany and lagging behind Italy and Scandinavia. The majority of the marketing applications surveyed had been installed in 1997/1998, illustrating how rapidly E-commerce country profiles are changing.

The situation will also change significantly again within the next two years, according to the Deloitte & Touche and Romtec surveys. *Figure 4* shows the growth anticipated by Deloitte & Touche in marketing, transactional (sales and post-sales) and supply chain (purchasing) applications. The figures for Western Europe suggest slower growth in each application area than for the survey as a whole, although they are in line with the survey's growth predictions for the world's other two major markets, North America and Asia Pacific.

Overall penetration levels of post-sales applications are generally lower than marketing and sales (see section 3.4.). The minority of businesses not intending to put such applications in place until after the millennium is also significantly higher here than in other application areas. Early examples of electronic delivery and electronic delivery-tracking applications using the Internet do exist, but there are currently few examples of successful post-sales customer service applications. While examples of world-leading parcel delivery companies providing tracking applications across the Internet are well-known, companies putting other post-sales applications in place include:

- Buyonet, a Swedish software supplier, has developed an electronic delivery mechanism for downloading software securely, guaranteeing the file's integrity when it reaches the customer before accepting payment.
- Cedlerts Fisk, a small Scandinavian supplier of luxury, perishable foodstuffs which enables customers to check order fulfilment and delivery times over the web.
- Banque Transatlantique, which provides customers with a loan simulator that allows them to view different scenarios for their loan payments, and a secure correspondence service with their banking consultant.

2.3. Impact on competitiveness and organisation

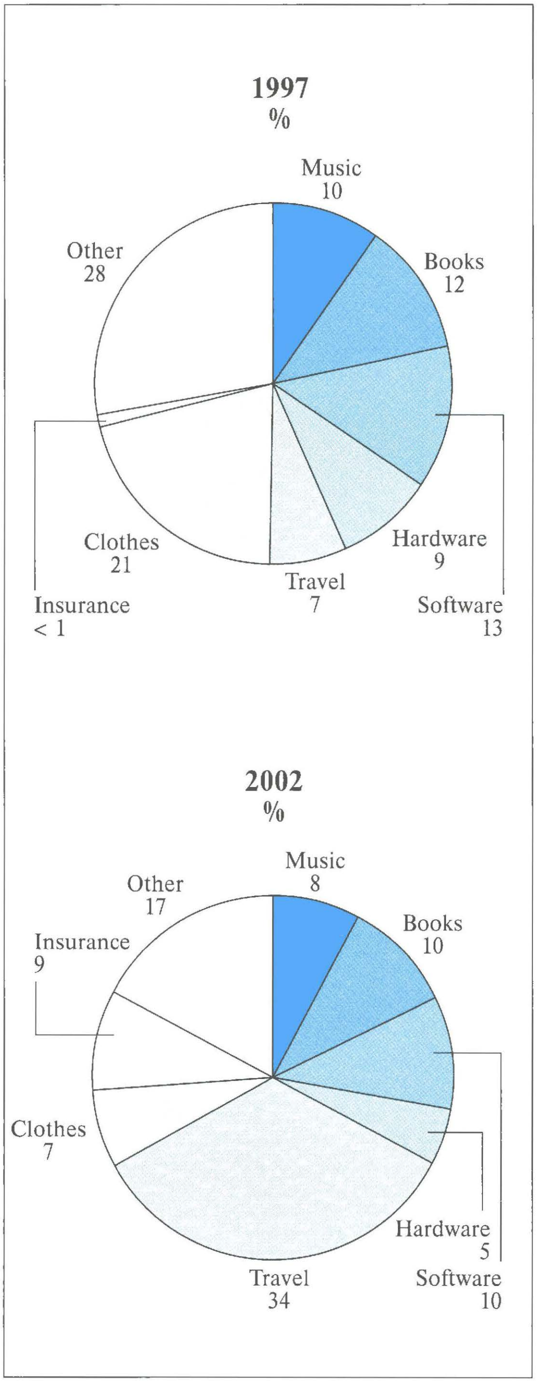
2.3.1. Staying competitive

The E-commerce market is becoming more competitive in two ways:

- An increasing amount of business is being carried out through online channels in certain sectors (books, computer software and hardware, music and travel), in competition with traditional channels.
- Within the E-commerce channel, Internet-only companies are beginning to face severe competition from rivals in a marketplace with no physical constraints to expansion.

Datamonitor[1] estimates that online shopping at European web sites will rise from ECU 95 million in 1997 to ECU 4.3 billion by 2002. *Figure 5* shows the proportion of that spend by

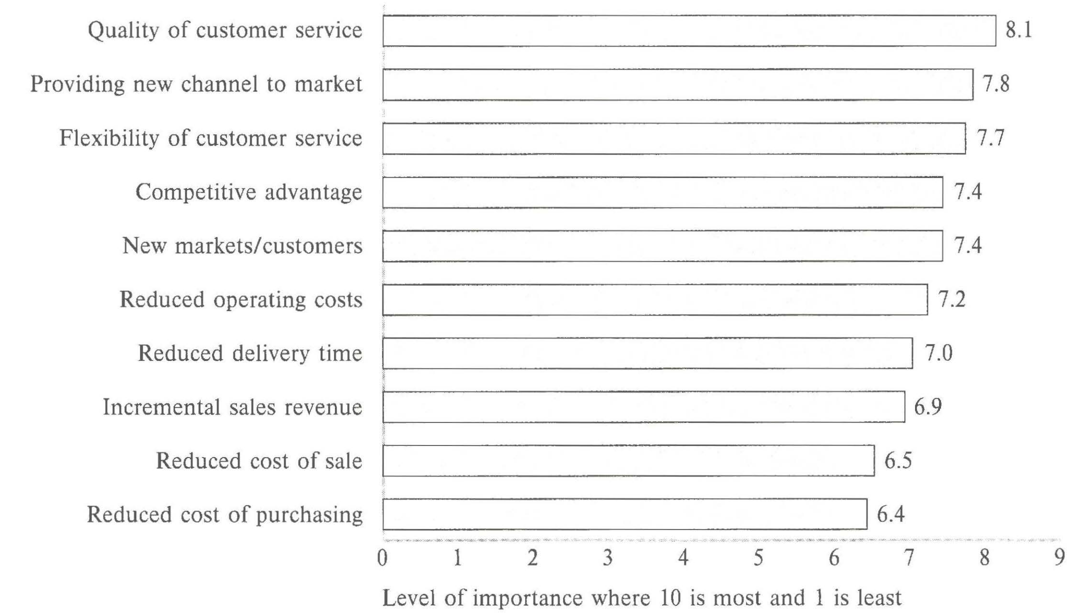
Figure 5
Product mix for online shopping, 1997 and 2002



Source: Datamonitor 1998

[1] Electronic Commerce Integration Services, Datamonitor 1998

Figure 6
Importance placed on benefits from use of E-commerce



Base: E-commerce users/ planned users (334-433 respondents)

consumer goods category. Increasingly, sophisticated sites that allow consumers quickly and easily to compare prices and find the best deal are encouraging greater shopping online rather than through conventional channels, particularly in the case of books, music and travel.

In this environment, the received wisdom is that companies should adopt two competitive strategies:

1. re-engineer their business processes onto electronic networks to reduce costs;
2. provide value-added services on top of commodity products.

Survey results show that most European companies are not motivated onto the Internet by the opportunity to reduce costs. In the Romtec survey (see *Figure 6*), reduced costs was listed fifth in a ranking of benefits, after much more important motivators such as improving quality of customer service, and access to new customers and markets. Reduced costs are a by-product of E-commerce for many companies, with the exception of Internet-only businesses, such as Swedish software distributor Buyonet (see *Table 1*).

Where an E-commerce market segment is maturing and therefore becoming highly competitive, for example in the global financial services sector, reducing costs does rank more highly. In the Ernst & Young survey[1] of this sector, 23% of all businesses considered "Decreasing the cost of operations" the most important goal of E-commerce. However, the Ernst & Young survey found that European companies were nearly three times more interested than US companies in gaining new customers (17% vs 6%). This bears out the Romtec finding that European companies are motivated by access to new customers.

[1] 1998 Special Report on Technology in Banking and Financial Services, Ernst & Young

Table 1
Reducing costs through Internet E-commerce

Type of business	Description of process change	Main pre-Internet E-commerce costs	Main Internet E-commerce costs
Buyonet	Losing money because of the high cost of physically distributing software in its geographic markets: decided to set up a business to carry out electronic delivery of software	Retail outlets Advertising, marketing, packaging Shipping from suppliers Onward shipping to customers Handling returns Inventory Administration/staff	Marketing and advertising Initial investment in E-commerce technology Maintaining E-commerce server (Able to offer products at competitive prices due to no handling charges)
H&R Johnson Tiles	Encouraging small suppliers to order and track deliveries online, rather than by fax, phone, or in person	Postage/fax/phone Staff/administration Mistaken order rectification Large inventory	Web site development and design Reduced inventory (The company is servicing a higher number of orders more efficiently with no increase in staff)

Quality and flexibility of customer service rated highly as E-commerce benefits among the European companies surveyed by Romtec. This suggests that businesses expect competitive advantage to come through adding value, rather than through price competition.

There are early examples of companies in commodity industries, such as travel, building value-added infrastructures to support customers (see case study).

Case study: Scandinavian travel company

This company is developing an Internet-based travel service aimed at attracting business travellers who would otherwise make their travel arrangements directly with international and local travel providers. The value-added services provided by the company will be tailored to individual traveller profiles.

The company will arrange every aspect of a customer's travel itinerary, and reschedule the itinerary automatically, without the need for user intervention, in case of flight delay, for example. The service will provide maps, weather reports, exchange rate information, and guides to restaurants, nightlife and interesting places to visit, as well as online booking and payment functions. All expenses incurred on the business trip – for example, flights, hotels, meals, taxis, entertainment – will be collated by the service and a consolidated bill sent to the customer at the end. As a one-stop electronic storefront for travel-related and even, once user loyalty has been established, non-travel-related services, the service will cater for mobile workers who have neither the desire nor the time to pull together information from multiple sources, and transact separately with multiple service providers.

Competition on the Internet is currently greater than competition between the Internet and existing channels to market and is intensified by there being relatively few customers and a lack of global boundaries. The provision of Internet E-commerce services is seen as a mechanism for retaining customers – a highly rated business goal among financial services customers in the Ernst & Young survey, where the average respondent has a customer turnover rate of 8% a year (6% due to relocation). However, the same technology can enable customers to switch to new service providers very easily, regardless of the provider's physical location.

40% of organisations in the Romtec survey were motivated to take up E-commerce by peer pressure from existing competitors. Once on the Internet, competition can be strong: the Internet music company, Cerberus, finds that any innovative moves it makes are very quickly copied by competitors, and this has an impact on its customer base (see case study).

Case study: Cerberus' online music venture goes back to the high street [www.cerberus.com]

Since January 1996, Cerberus has sold dance music tracks across the Internet. Cerberus does not release details of numbers of customers and revenues, but these have been sufficiently disappointing, and Internet competition sufficiently fierce, that it will also use a more traditional distribution channel, the high street retail outlet, as a complement to its Internet business in the future.

In October 1998, Cerberus launched the Virtual Record Store, a multimedia kiosk that will sit in high street retail outlets and enable customers to select from 50,000 tracks to record their own CDs in minutes. Cerberus has an agreement with Levi Strauss to host the Virtual Record Store in each major city in Europe. Where feasible, kiosks will be linked to Cerberus' Internet site, and there will be cross-advertising of the two channels. However, the system is designed to be updated independently of the Internet, weekly or monthly via CD-ROM. Cerberus suggests the music market is still too immature for the single channel approach it had formerly taken.

2.3.2. Changing organisations

Optimism over E-commerce application growth is registered by both the Romtec and Deloitte & Touche surveys, yet it is currently having very little impact on existing organisations in Europe. While there are examples of software distributors turning themselves from physical to Internet-only companies, there are few, if any, in other European industry sectors. In the majority of cases, Internet-only companies are new start-ups, and many of them are intermediaries in new market areas, that is, "middlemen", providing Internet-based services that enable buyers to find sellers, and vice-versa, in particular markets.

The start-up intermediary position is a lucrative one: such companies typically turn over a high volume of business with very low overheads. Quixell was set up in September 1997 to auction computer products, and now, as Europe's largest online auction company, with an expected turnover in its first year of trading of 4.2 million ECU and 20 staff, auctions a growing range of items, including consumer electronic products, jewellery and timeshare holidays.

Intermediaries will play an increasingly vital economic role over the next two to five years in matching suppliers and customers, potentially creating a competitive environment in favour of the smaller, more "agile" and niche supplier over larger businesses. At this point, E-commerce will begin to have an impact on many more organisations.

Today, when businesses, large and small, open up a new channel to market through the Internet, they are typically doing so without significantly changing their existing business, or taking on new staff. Cedlerts Fisk, for example, services orders to consumers, which are taken via the Internet, in the quiet moments when its staff are not fulfilling orders for business customers. Surgicon, a small UK distributor of surgical products, has redeployed staff as a result of putting an online order and fulfilment capability in place.

Internet-based E-commerce pilot operations in food retail are often add-ons to the rest of the business. Such pilots are proving uneconomic to roll out on a large scale, and it is likely that companies will have to adopt a different business model, with a much leaner organisational structure, in order to succeed more widely on the Internet.

Organisational "shrinkage" is being enabled by E-commerce in the more advanced North American E-commerce market. British Airways has decided to close its physical sales outlets in the USA because of the success it has had selling tickets over the Internet. As the propensity for buying online increases in Europe, Datamonitor predicts that such moves will be replicated here, too.

However, organisational change will generally be slow in enterprises serving traditional consumer markets. In the financial services sector, Ernst & Young found that more than 21% of its businesses did not intend to make changes in other channels because of investments in E-commerce. The number of businesses indicating that they would provide incentives for customers to use lower-cost E-commerce delivery channels fell from 85% in 1996 to 72% in 1997, while the number of businesses with no plans to do so rose. Romtec's survey findings in the finance, retail/wholesale and transport/travel sectors confirm that these sectors are proceeding cautiously, with significant impact on their existing organisations unlikely before 2001.

2.4. Issues for E-commerce

2.4.1. Public infrastructure

The continuing expansion of the Internet, as illustrated by the fact that in July 1998 Network Wizards estimated that there were more than 36 million hosts worldwide [www.nw.com], and that Nua Ltd estimated that in August 1998, there were 147 million adults with access to the Internet [www.nua.ie], suggests there will be increasing E-commerce opportunities as an ever-greater potential customer base comes online. Nua estimates that Europe accounts for 22% of the worldwide Internet population (with the USA/Canada holding 58%, Asia Pacific 15%, South America 3%, Africa 1% and the Middle East 1%).

Schema[1] estimates that by the end of 1997 the total number of companies using Internet Protocol (IP) services in Europe reached 2.6 million, representing 4.1 million sites. On the basis of a survey conducted between January and June 1998, Schema has derived figures for the number of business Internet subscriptions by country (see *Figure 7*). It forecasts that the number of connected business sites will grow to 10.6 million by the end of 2003. Within the same timeframe, residential subscriptions are predicted to grow from 6.3 million to 30 million in Europe.

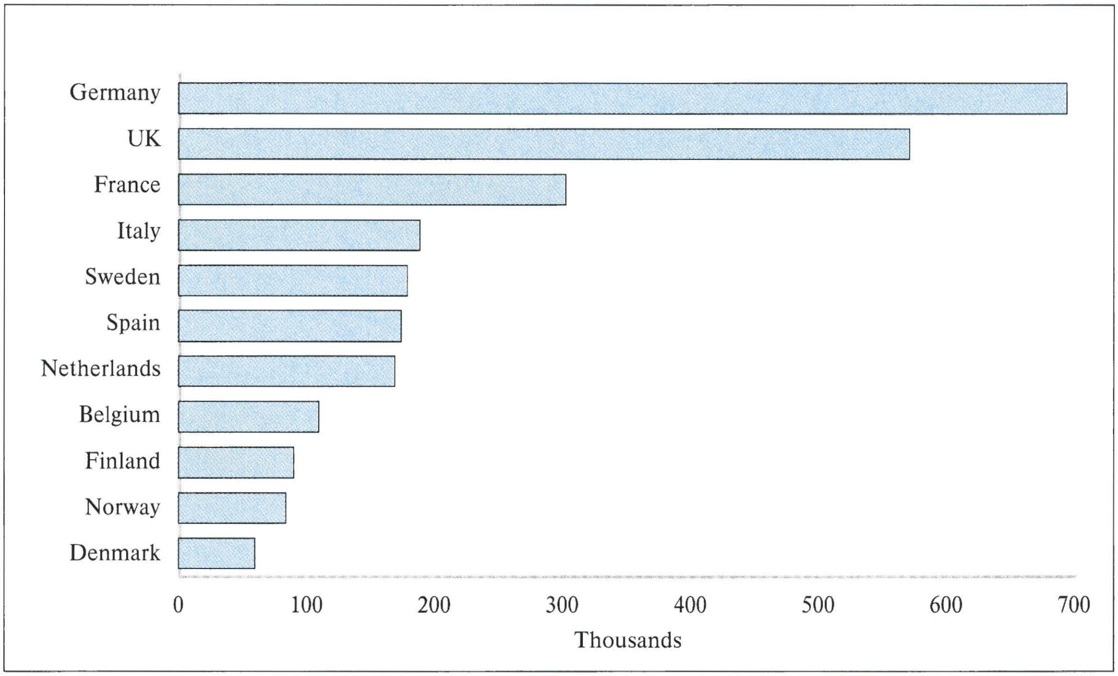
This growth will have an impact on Internet infrastructure, including access, bandwidth and governance issues. The increase in Internet Service Providers is facilitating access to the Internet, although as there are now an estimated 20,000 to 30,000 ISPs worldwide, most of which are very small, it is likely that there will be a market shakeout over the next few years. This is likely to consolidate service provision in the hands of far fewer companies. At the same time, the face of Internet service provision may change as it becomes more deeply embedded into the service offerings of other industry sectors.

In advanced E-commerce country markets, such as the UK, retailers and financial services companies are moving into Internet service provision, making the Internet accessible to large numbers of consumers who would not otherwise experiment with this medium. [www.oecd.org/dsti/sti/it/index.htm] provides information on Internet infrastructure indicators, including governance issues.

Infrastructure improvements and greater choice of bandwidth services mean that the Internet is becoming an increasingly efficient and reliable medium over which to conduct

[1] Communications in the Internet Era: The Market for IP-based Services in Europe, Schema 1998

Figure 7
Business Internet subscriptions in Europe



Source: Schema 1998

E-commerce. Major bottlenecks and costs currently in the local loop and in customer support may deter consumers from participating in E-commerce, but backbone traffic has a fairly constant profile at present, attracting business-to-business users to use cheaper Internet services rather than private network connections for certain types of E-commerce traffic. However, capacity and switching/routing in the international backbone may become a bottleneck in the coming years, discouraging business-to-business users from using the public Internet, unless this problem is addressed.

2.4.2. Private infrastructure

Demand for E-commerce-related applications is shaping organisations' private infrastructures. The use of the web and private EDI networks to bind customers and suppliers into transactional business processes, videoconferencing in support of collaborative working, marketing and distance learning, and the use of multicast push technology to deliver electronic products and services, are all having an impact on corporate networks.

It is costly and complex to implement in-house private network infrastructure that: delivers high bandwidth end-to-end; supports multimedia communications – voice, video and data; and supports a quality of service capability that will commit bandwidth to real-time applications, such as voice, video, and business-critical transactions. Companies are beginning to turn to third parties, such as ISPs, to provide the private infrastructure they need to support Intranet and E-commerce applications.

The blurring of boundaries between public and private infrastructure, which has made E-commerce possible, will gain momentum as E-commerce applications themselves become more widespread and sophisticated. Trends for the future include companies making private network infrastructures available to trading partners as Extranets and the increasing extension of E-commerce across wireless networks, such as enhanced GSM, its third generation successor, and newly-emerging satellite networks.

2.4.3. Technology

Four technology building blocks are critical to the future development of E-commerce:

- E-commerce servers;
- electronic payment;
- smart cards;
- network access devices.

E-commerce servers

E-commerce server software has steadily increased in function over the past three years. 1996 saw the take-up of the first sophisticated commerce servers aimed at high-end transactional environments in Europe (such as the first cybermalls), and also the launch of the first low-cost solutions for individual merchants. By 1998, the market was less well-defined, with new highly customisable E-commerce "framework" products making an entrance.

E-commerce servers increasingly incorporate middleware and support for standards such as EDI to enable integration with back-office operational systems, including enterprise resource planning (ERP) and logistics systems. At the same time, the developers of such systems are extending them to support Internet E-commerce. In two years' time, an organisation's key operational systems may well contain many of the applications currently separated out into E-commerce servers today. The Internet will merely be one of many channels to market, with a consistent set of back-office processes operating across all channels.

The full set of functions needed to carry out secure E-commerce is still too expensive for small and medium-sized organisations. A number of commercial E-commerce application services are beginning to appear which serve this business-to-business market: in many cases, such as Electronic Mall Bodensee, they are adaptations of successful business-to-consumer E-commerce implementations.

Case study: EMB [www.emb.net]

In 1998, Electronic Mall Bodensee believes it achieved the goals it had set out to reach, becoming a "marketplace" in the fullest sense of the word, supporting the commercial, political and cultural life of the Bodensee region in Germany, Switzerland and Austria. The services now provided by EMB include:

- *a directory service with full search capabilities, listing 1,350 commercial and institutional sites in the region;*
- *a shopping centre currently consisting of 13 electronic shops owned by small and medium enterprises in the region. In mid-1998, EMB managed to gain support from a German acquiring bank for cross-border credit card transactions, enabling online payment using the SET protocol to be put in place. The only continuing problem here is that all goods have to be priced in German Marks.*

EMB had to customise its E-commerce server solution heavily to support business-to-consumer E-commerce. However, it intends to capitalise on its investment by establishing a business-to-business transaction platform based on the same technology.

A further EMB project involves a group of companies in a particular part of Bodensee setting up a platform that will support electronic purchasing and the publication of invitations to tender. An initial 12 companies are involved in establishing the platform and publishing product catalogues online, but more companies are expected to join in 1999. At the same time, EMB is running a pilot project which aims to establish an infrastructure for electronic government across the region.

Electronic payment

The three main forms of payment supported by E-commerce sales applications are:

- credit card;
- electronic cheque;
- electronic cash.

Credit card is still the most popular form of payment on the Internet.

A 1998 survey carried out for ICL[1] by MORI to determine attitudes towards technology and its impact on lifestyle in four European countries (Sweden, Germany, France, UK) and the USA, found that around 40% of the 3,500 businesses were favourable towards the idea of electronic cash. In Europe, the Swedes were most in favour (50%) followed by the French (44%) and Britons (39%), just ahead of the Germans (37%).

[1] The Lifestyle Revolution, ICL 1998

Though a technology important to underpinning business-to-consumer E-commerce, E-cash has been slow to make an impact on the market. In 1998, issues of competing smart card technology and interoperability between payment mechanisms began to be addressed. This will help to accelerate acceptance of E-cash, as will clarification over the role of, and regulatory environment for, E-cash issuing organisations, which is now emerging in Europe.

Smart cards

Multi-application smart cards, which underpin other key E-commerce technologies, including E-cash and E-commerce-enabled mobile phones, have now emerged from the concept stage and started to ship in 1998. France is in the best position to make the transition to multi-application smart cards: over 20 million customers of French banks possess smart card-based credit cards. Scandinavia is also ahead in the roll-out of such cards. At the end of 1997, Sweden Post launched a smart card-based secure E-mail service (@Post). By the millennium, it expects four million Swedes to be carrying smart cards that give them access to @Post and other Internet-based services.

Smart card technology for E-commerce faces cultural barriers. In the MORI survey, UK businesses (60%) were most interested in a single smart card that would allow them to reduce the number of other cards to just one, compared to 42% in Sweden, 43% in Germany and 45% in France. The ability to pay electronically was not seen as a perceived benefit of smart cards.

Multi-application smart card issues include security, rival operating system technology, the lack of mature development tools, interoperability with different types of reading device, and the definition of a cardlet loading protocol. Industry fora are gradually resolving these issues.

Internet access devices

An expanding range of devices able to access the Internet will accelerate its penetration within Europe and increase the potential consumer base for E-commerce. Until 1998, the only means of connecting to the Internet has been via a computer and modem. From 1999, this will change as other Internet-enabled devices become available.

Web-enabled mobile phones, due in 1999, will become one segment of a larger category of handheld mobile information devices. Information-centric devices, with built-in modems or PC cards, support for Internet access protocols and native browsers, began shipping in 1998. By the end of 1999, the first information-centric products are scheduled to appear, supporting wireless technology known as Bluetooth[2]. This will enable sophisticated mobile E-commerce applications, such as mobile electronic dealing rooms and mobile travel applications, to be developed. The low cost of such units compared to PCs will help push Internet-based E-commerce to a broad customer base.

[2] Bluetooth is a set of standards for wireless communications, developed by the Bluetooth Consortium (which includes companies in the telecommunications and computer industries such as Cable & Wireless, Compaq, Motorola and One 2 One)

Multimedia kiosks providing pay-as-you-go access to the Internet have already been successfully installed in pilot locations, such as the city of Tampere in Finland. Although they have the potential to increase access to the Internet, they face similar infrastructure and cost-of-investment barriers to smart cards and are unlikely to be in widespread use across Europe until after the millennium.

The first trials combining digital television with access to the web began in Europe in the second half of 1998 and manufacturers of set-top boxes and televisions for the European market are producing early equipment that supports Internet access. This equipment is expected to appear in volume from 1999 onwards.

Digital television has the potential to deliver mass-market access to the Internet, but subsequent E-commerce opportunities may take several years to realise. Among the countries in Europe, Belgium is in a unique position to capitalise early on such an opportunity: 95% of Belgian homes are connected to cable television, the infrastructure for which is being upgraded over the next four years into a high-speed bi-directional digital information highway.

2.4.4. Security

Security is still a barrier to electronic commerce, although increasingly security risks are being weighed against the commercial risks of delaying exploitation of the Internet. The Romtec survey found that uncertainty over business benefits, resulting in a "wait and see" attitude (mentioned by 24% of businesses), was a stronger disincentive to adopt E-commerce than security (mentioned by 15% - see *Figure 43,* page 216). In its 1998 Global Survey of Chief Information Executives, Deloitte & Touche Consulting found that security came top of CIO's list of barriers to the development of all types of Internet E-commerce applications. Nevertheless, the same businesses expected a dramatic rise in the numbers of such applications over the next two years.

The security technologies needed are particularly expensive for small and medium-sized (SME), companies. Many such organisations setting up Extranets, currently do so with very low levels of security, basing proof of identity (authentication) on easily-hacked passwords, rather than on encrypted keys, certificates and digital signatures.

Larger organisations are beginning to put in place certificate-based security infrastructures. The investment bank Soundview Financial Group forecasts that this market for certification authority products and services will reach ECU 940 million worldwide in 2001.

2.4.5. Other issues

There are other important issues not addressed in this chapter, but the following web sites may be helpful to readers requiring more information:

Regulatory issues

- **consumer protection:**
  [www.oecd.org/dsti/sti/consumer/index.htm]
  [www.echo.lu/legal/en/internet/internet.html]
- **security, including digital signatures, authentication, certification and encryption:**
  [www.ispo.cec.be/eif/policy/97503toc.html]
  [www.oecd.org/dsti/sti/it/secur/index.htm]
- **taxation**
  [www.oecd.org/dsti/sti/it/ec/index.htm]
  [www.ottawaoecdconference.org/english/homepage.html]
- **domain names and trademarks**
  [www.ispo.cec.be/eif/policy/governance]
  [www.oecd.org/dsti/it/index.htm]

Standards

[www.cenorm.be] (this provides references to all other formal or informal standardisation bodies)

Privacy

[www.ispo.cec.be/ecommerce/docs/personaldirective.pdf]
[europa.eu.int/comm/dg15/en/media/dataprot/index.htm]

Liability, contract law and commercial communications

These issues are dealt with in the Commission's proposal for a Directive for a legal framework for electronic commerce. The Web address is the following:

[europa.eu.int/comm/dg15/en/media/eleccomm/999.htm]

3. Current status of the E-commerce market

3.1. Summary

The baseline technologies to support E-commerce are in place in 1998 within a large number of companies across countries and industry sectors. 1996 saw the beginning of strong growth in connections to E-mail and the Web among Romtec survey respondents. This reached a peak in 1997 and has dropped back only marginally in 1998. As a result of this growth in infrastructure, there has been a surge in the number of E-commerce applications installed in 1998 and planned for 1999. In this section, we look at:

- the status of the E-commerce market, in terms of infrastructure and spend on E-commerce technology;
- use of the Internet, by E-commerce application.

3.2. Infrastructure

3.2.1. Internet access

E-mail is a basic starter application for E-commerce and in 1998, 80% of all companies surveyed have E-mail (68% of all companies having both E-mail and web connections).

Amongst those businesses that have E-mail installed, the proportion of businesses connecting to E-mail was low up until 1996, with the majority of current E-mail using companies (82%) connecting between 1996 and 1998 *(Figure A2 in the Annex)*. The sectoral picture shows that a small but significant proportion of utility and other services companies installed E-mail before 1994. By 1995, finance, retail/wholesale and business services were beginning to catch up, before the explosion in connections across all industry sectors in the past three years (1996-1998 - *Figure A3 in the Annex*).

UK companies led the way in Internet connection, with 20% of current E-mail using businesses claiming connection before 1994, well ahead of Benelux, with 12% of such businesses connecting before 1994. German and Scandinavian businesses began to follow suit in 1995. France and Spain have been connecting heavily in the 1997/1998 period, with 78% and 70% of current E-mail using businesses respectively putting E-mail in place within this timeframe (*Figure A4 in the Annex* shows connection by country pre- and post-1996).

1997 was a key year for connection to the web, with companies starting to implement this facility in large numbers. For example, 75% of planned E-commerce users (which are current Web users) connected to the Web in 1997 and 1998. In 1997, the financial and manufacturing sectors led in terms of the proportion of current Web users which connected to the Web in that year, with business services leading in 1998, at a level sustained from 1997 (38% of current Web users). Web connections in Italy soared in 1997 - 50% of Italian businesses which are connected to the Web connected in this year, compared to 37% of French and German businesses. However, France and Spain pushed ahead in 1998, with 41% and 33% of web-using businesses in these countries respectively connecting to the Web (see *Figures A5-A7 in the Annex* for analysis of pre-96 and post-96 connection to the Web).

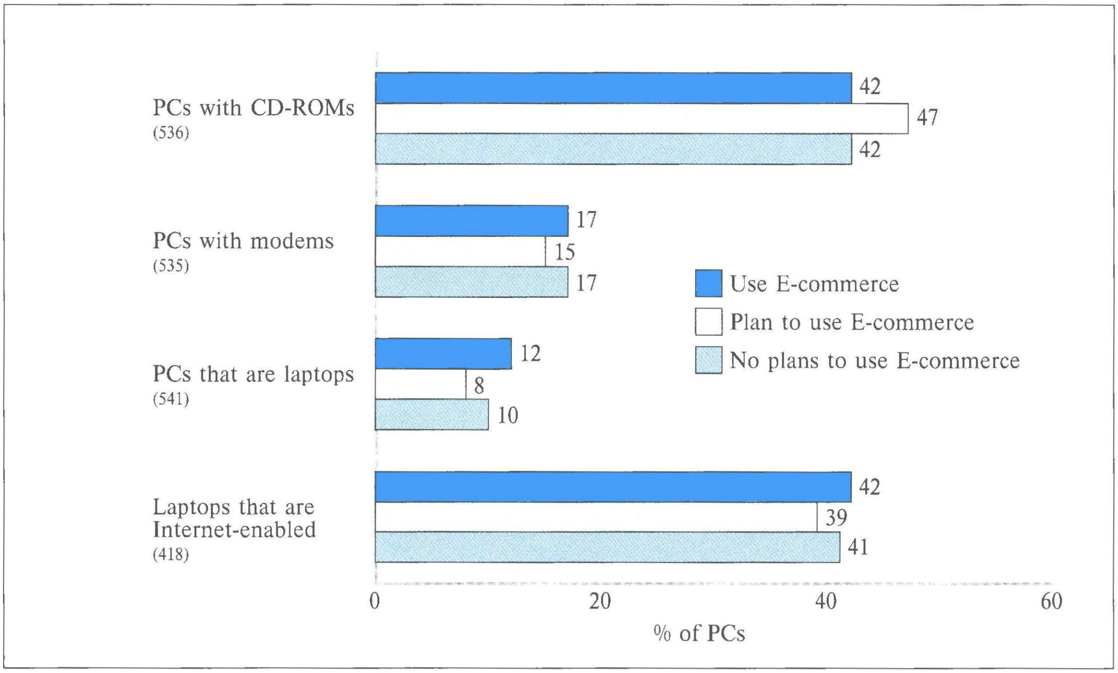


Figure 8
Types of PCs and their specific additions

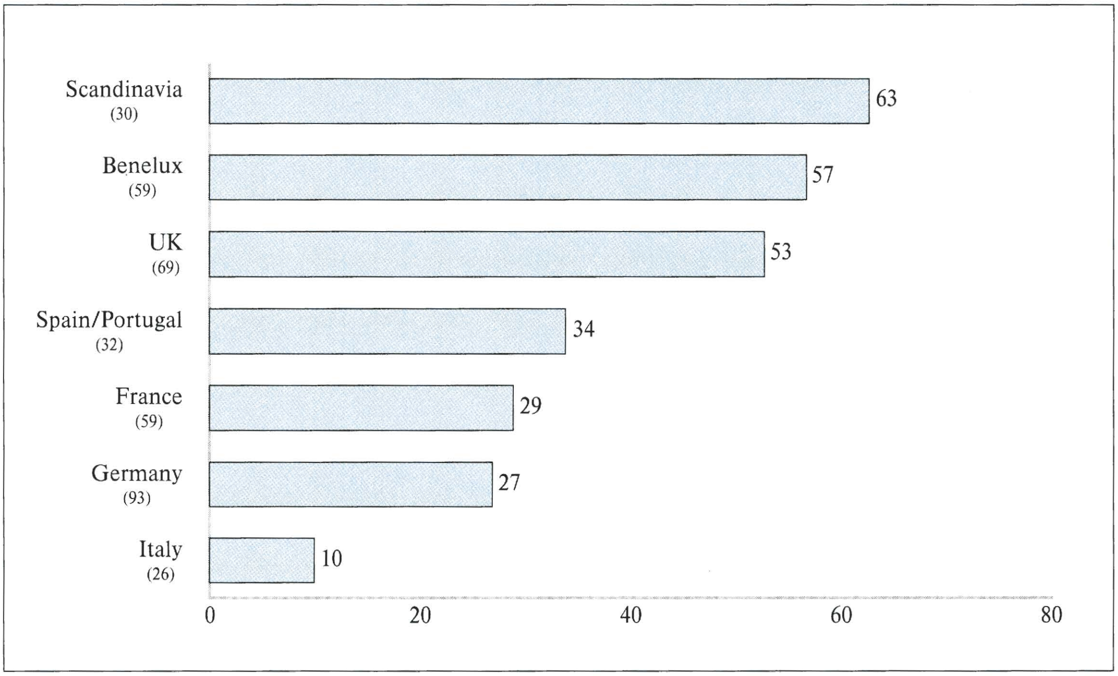
Note: Figures in the brackets show base

Nevertheless, there remains a significant proportion of organisations that are unconnected to the Internet and web. Almost a third of companies with no plans for E-commerce remain unconnected, compared with only 21% of planned users. 10% of existing E-commerce user companies do not have Internet connections, which suggests that they are not interested in exploring alternatives to EDI-based E-commerce over private networks.

3.2.2. Internet-enabled devices

Although a high proportion of companies have the connections to enable them to carry out E-commerce, the proportion of PC users within organisations which would actually have access to E-commerce (i.e. those PC users that have a modem) is still relatively low. In this respect, companies with no plans to develop E-commerce are in as prepared a position as E-commerce users and planned E-commerce user companies. For example, on average, 17% of PCs in companies with no plans have modems, compared to 15% of PCs in companies with E-commerce plans *(Figure 8)*. Companies which are already using E-commerce also have, on average, 17% of PCs that are modem-enabled. As might be expected, a much higher proportion of laptops in each category are enabled, allowing companies to support remote working and Intranet applications. However, overall, penetration of laptops is low with, again, companies with no plans having, on average, a marginally greater proportion than companies with E-commerce plans. The latter group lead in the number of multimedia PCs, however with, on average, nearly half of their PCs equipped with CD-ROM drives.

Figure 9
Percentage of laptops that are Internet-enabled (by country)



Note 1: Figures in the brackets show number of respondents
Note 2: Selected countries only shown
Base: Organisations with laptops

These figures are comparable with IDC findings that in 1997, 26% of all PCs/network computers (NCs) in Western Europe were used to access the Internet (IDC considers access to the Web to be a subset of Internet access). By 2001, however, it expects that 54% of the installed base of PCs/NCs will access the Internet. IDC points out that this will still leave an estimated 50 million devices in Western Europe that do not have access.

IDC finds that devices in medium/large Western European businesses were most likely to have access (39%) in 1997, with small businesses the least likely (20%), after the home (21%).

By country, IDC reports that Finland had 41% of PCs/NCs able to access the Internet by year-end 1997, followed closely by its Scandinavian neighbours: the UK ranked joint fourth with Denmark with 33% of devices having Internet access. At the bottom of the ranking came France, with 13%; penetration in Germany was 26%. IDC sees a changed picture in 2001, however, when Germany, with an expected 69% compound annual growth rate in the number of devices connecting to the Internet, will outstrip the UK in the raw numbers of connected devices: 20.3 million compared to the UK's 13 million (46% CAGR).

Romtec's survey bears out the advancement of Scandinavian countries: Scandinavia had the highest penetration (24%) of PCs that are modem-enabled, although Germany had one of the lowest – 15%. Italy and Benelux had the lowest penetration figures at 11% and 10% respectively. While Italy remained low in the laptop-enabled category *(Figure 9),* Benelux businesses, however, said that 57% of their laptops were enabled, second only to Scandinavia (63%).

Million ECU	1997	2001
Services	195	6,590
Hardware	65	1,250
Software	65	1,860
Total	325	9,700
%		
Services	60	68
Hardware	20	13
Software	20	19
Total	100	100

Source: Datamonitor 1998

Table 2
Business-to-business set-up spend split by services, hardware and software in Europe, 1997-2001

Note 1: All figures are Datamonitor estimates
Note 2: Rounding errors may occur
Note 3: For the Datamonitor figures, Europe includes all EU countries, plus Norway and Switzerland

ECU, average set-up	1997	2001
High-end solutions	640,000	560,000
Low-end solutions	42,700	16,200

Source: Datamonitor 1998

Table 3
Business-to-business solutions spend, 1997-2001

Note: All figures are Datamonitor estimates

Million ECU	1997	2001	CAGR %
Germany	95	2,410	124
UK	73	2,130	132
France	30	740	123
Italy	21	680	139
Spain	13	580	158
Netherlands	13	480	147
Sweden	9	480	170
Other Western Europe	73	2,200	134
Total	327	9,700	133

Source: Datamonitor 1998

Table 4
Business-to-business total Internet EC set-up expenditure in Europe, by country, 1997 and 2001

Note 1: All figures are Datamonitor estimates
Note 2: Rounding errors might occur
Note 3: CAGR (Compound Annual Growth Rate)

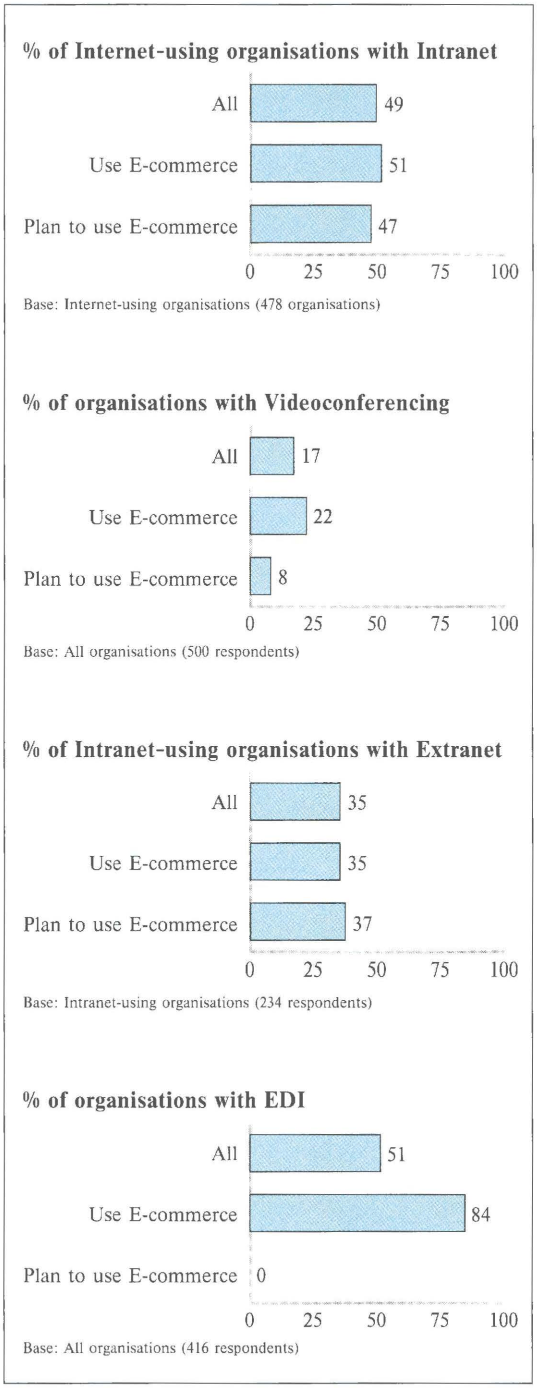
3.2.3. Internet E-commerce IT spend

Datamonitor has estimated the set-up expenditure on business-to-business E-commerce technology in Western Europe from 1997 to 2001. *Table 2* shows that the majority of the spend will be on services, due to the high element of customisation needed to build E-commerce infrastructures in the business-to-business sector. *Table 3* shows projected spend on high-end and low-end E-commerce solutions. Datamonitor expects low-end solutions to account for 57% of spend in 2001, as small and medium-sized companies start building electronic links and form new trading communities and value chains. Although Datamonitor does not specifically define the terms “high-end” and “low-end”, low-end E-commerce servers start at as little as ECU 3,000, while a high-end solution may cost around ECU 100,000.

However Romtec’s survey warns against a too-easy assumption that small sites will necessarily buy low-end solutions. The high number of small sites which are already E-commerce users in its survey suggests that small sites have already invested significantly in E-commerce solutions. Small sites that expect a significant proportion of their revenues to come from E-commerce operations will need the sophistication and customisation of high-end solutions.

As an example of how the status of E-commerce varies by country, Germany and the UK were by far the highest spenders on business-to-business E-commerce solutions in 1997, with Germany spending ECU 95 million and the UK ECU 73 million, according to Datamonitor *(Table 4)*. This trend will continue, with their respective spends in 2001 projected to be ECU 2.4 billion and ECU 2.1 billion. Spain will make the heaviest investment over this period however, jumping from ECU 13 million in 1997 to ECU 580 million in 2001, and continuing to grow thereafter; Italy’s spend will also grow ahead of the current market leaders and France, too, is in catch-up mode. Datamonitor finds large manufacturers and retailers leading the way in Internet E-commerce investment, which many regard as a natural extension to their existing EDI-based activities.

Figure 10
Organisations with different electronic services



3.3. Penetration of electronic services

3.3.1. Intranets, Extranets and EDI

Nearly half (49%) of the Romtec survey respondents which are Internet users claimed to have Intranets, and of these businesses, around a third (35%) were Extranet users *(Figure 10)*. Most Intranet and Extranet using businesses installed their Intranet/Extranet within the past three years – 80% of Intranet using businesses installed their Intranet between 1996 and 1998, whilst 77% of Extranet using businesses installed their Extranet over the same time period.

A very high proportion (84%) of E-commerce user companies were EDI users, while only 35% were Extranet users. However, 30% of the businesses said they plan to switch from EDI to Internet-based E-commerce services within two years.

There are also clear sectoral differences in the uptake of electronic services *(Table 5)*. Intranets are most common within manufacturing and all types of services companies. Manufacturing leads very clearly in establishing Extranets, with 53% of manufacturing businesses claiming to be using them. Since Extranets are being set up at present to streamline the supply chain, this finding is not surprising, nor is the penetration of Extranets in the retail/wholesale sector. Very few transport/travel companies have Extranets, although they are the strongest users of EDI (72%).

The survey findings indicate that companies in the UK, France and Germany are not as likely as companies in other large European countries, such as Spain/Portugal and Italy, to have established an Intranet *(Table 6)*.

Spain/Portugal, Benelux, France and UK report a high penetration of EDI. Germany and Scandinavia are notably behind these countries in terms of EDI penetration.

Industry sector	Percentage of organisations that use **Internet-based E-commerce**	Percentage of organisations with an **Intranet**	Percentage of organisations that have implemented an **Extranet**	Percentage of organisations that use **EDI**	Percentage of organisations with capability for **videoconferencing**
Business Services	33	56	34	51	9
Manufacturing	30	54	53	58	32
Retail/Wholesale	25	43	41	46	13
Transport/travel	23	44	14	72	13
Utilities	16	45	24	47	9
Other Services	15	55	37	44	17
Finance	14	49	23	45	20

Table 5
Application capabilities of organisations, 1998 (by sector)

Country	Percentage of organisations that use **Internet-based E-commerce**	Percentage of organisations with an **Intranet**	Percentage of organisations that have implemented an **Extranet**	Percentage of organisations that use **EDI**	Percentage of organisations with capability for **videoconferencing**
Scandinavia	32	54	43	43	28
Germany	31	44	41	43	10
UK	29	43	28	53	25
Benelux	23	56	36	55	21
Spain/Portugal	13	57	38	59	9
Italy	12	56	22	49	10
France	10	48	26	54	21

Table 6
Application capabilities of organisations, 1998 (by country)

Note: Selected countries only shown

3.3.2. Videoconferencing

The use of videoconferencing is low amongst almost all types of company surveyed. Germany is a low user of videoconferencing, with 10% of businesses using it compared to 25% in the UK and 28% in Scandinavia. In terms of industry sector, manufacturing organisations (32%) are notably more likely than average to be users of videoconferencing. There is little penetration (9%) of videoconferencing among business services and utility companies.

Videoconferencing usage is at its highest amongst sites with 500 plus employees, 40% of which use videoconferencing – this compares to only 11% of sites with less than 500 employees that do so.

3.3.3. Internet-based E-commerce penetration

Note that E-commerce applications do not necessarily involve the execution of financial transactions (transfer of funds) across electronic networks.

Only a small proportion of current Internet-based E-commerce-using companies started to use E-commerce over the Internet in 1994 and 1995 (3% and 4% respectively – *Figure A8 in the Annex)*. Most Internet-based E-commerce using companies began to use E-commerce in either 1997 (34%) or 1998 (44%).

Figure 1 (see section 1.) shows Internet-based E-commerce penetration amongst European businesses and illustrates that penetration exploded in 1998 – E-commerce penetration will jump from 13% at the close of 1997 to 29% at the end of 1998 – and this impressive growth will continue in 1999, with almost a half (47%) of European businesses being Internet-based E-commerce users by the end of 1999.

The breakdown of Internet-based E-commerce users by country indicates that Scandinavia, Germany and the UK lead the way in terms of current usage of Internet-based E-commerce *(Table 6)*. Only 13% of businesses in Spain/Portugal, 12% of businesses in Italy, and 10% in France use Internet-based E-commerce.

The business services and manufacturing sectors are ahead of all others in their use of Internet-based E-commerce *(Table 5)*. Although not usually a laggard in the use of new technologies, the finance sector has proved so far to be one in the case of Internet-based E-commerce.

3.3.4. Use of electronic networks by application

It is difficult to determine from the survey data which type of electronic network some applications are using (that is, whether the application uses a private network service or the Internet). As a very high proportion of existing E-commerce users are also EDI users, it is likely that a proportion of the installed base of sales, invoicing/payment and purchasing applications are currently carried out across EDI networks. Marketing, recruitment and most types of post-sales applications, however, only make sense across the Internet.

This section assumes that the majority of applications currently installed use the Internet, particularly as a large percentage of businesses (65%) put them in place in 1998. It further assumes that almost all the applications planned will also use the Internet. Of the 30% of businesses who currently use EDI but intend to switch to Internet-based applications, 29% will do so in 1998 and 54% in 1999.

3.4. E-commerce applications

The survey looks at four major types of E-commerce applications:

- *Marketing:* advertising and promotion.
- *Sales:*
  - receiving orders from customers;
  - customer invoicing, collection and payment.
- *Post-sales and recruitment:*
  - online supply to customers (electronic delivery, or confirming delivery details electronically);
  - customer support (answering commercial or technical queries, providing updates, software fixes, news);
  - customer monitoring and relationship development (needs and satisfaction research, consultation);
  - recruitment of marketing/sales staff and non-marketing/sales staff.
- *Purchasing:*
  - searching for possible suppliers over the Web;
  - making purchasing commitments;
  - receiving purchases electronically, or receiving confirmation of delivery details;
  - receiving after-sales support from a supplier, such as answers to technical queries, progress reports;
  - receiving and responding to supplier requests for information and opinions;
  - payment of suppliers.

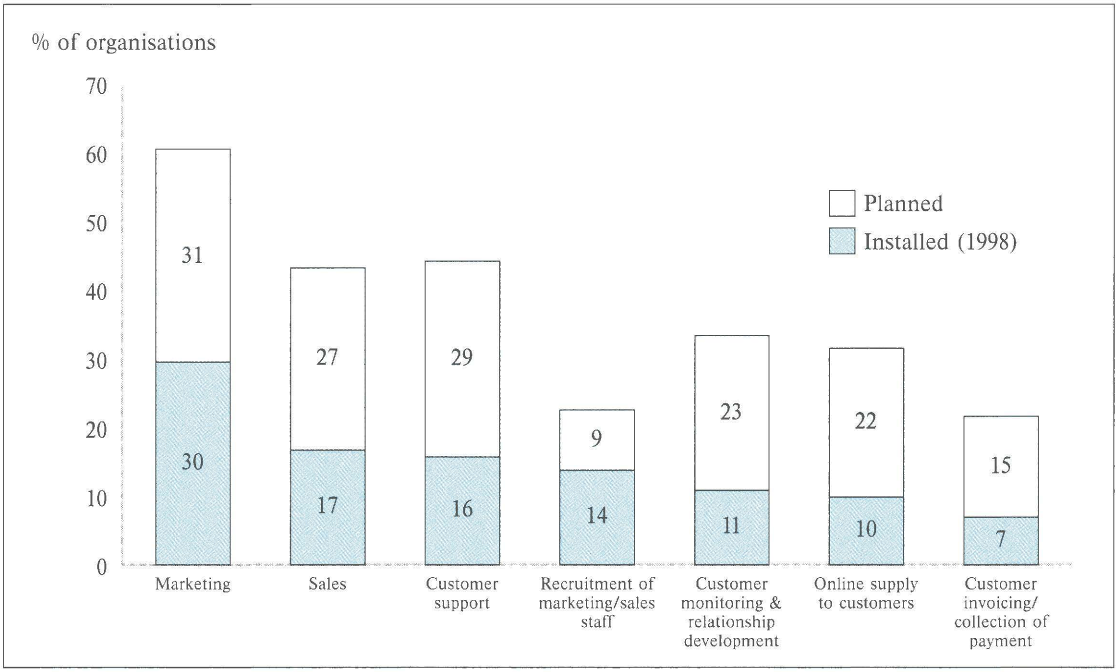


Figure 11
Current and future penetration of E-commerce customer-oriented applications – all European businesses

Base: E-commerce users/ planned users (450-457 respondents)

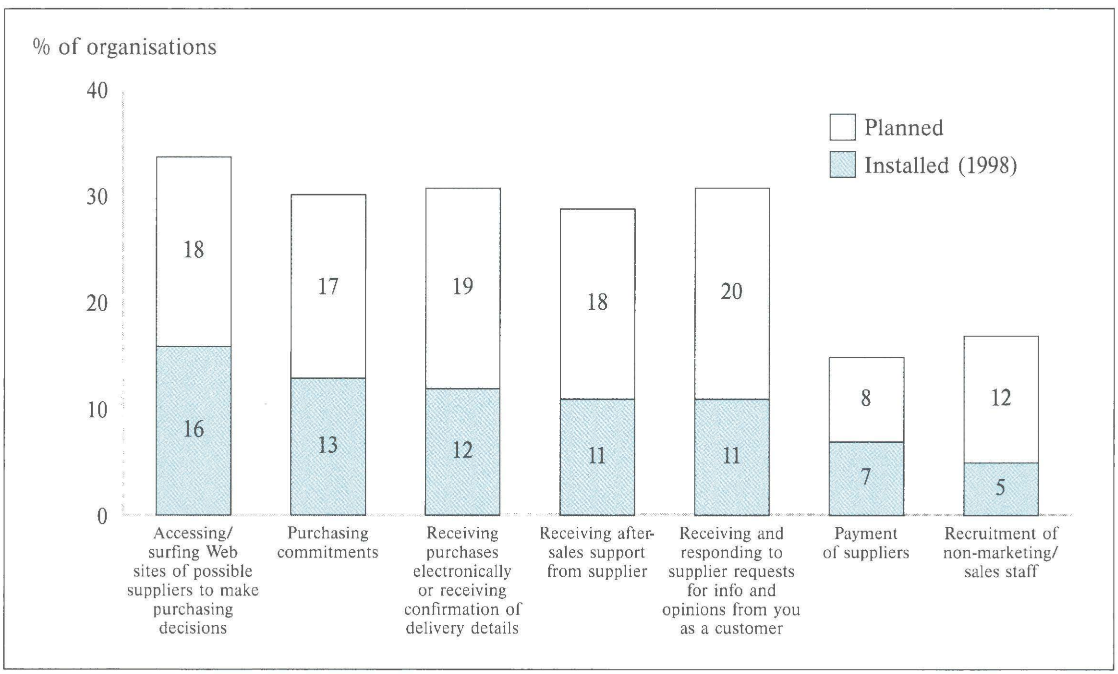


Figure 12
Current and future penetration of E-commerce supplier-oriented applications – all European businesses

Base: E-commerce users/ planned users (458 respondents)

Table 7
Current and future penetration of E-commerce applications (by country)

	Benelux		France		Germany		Italy		Scandinavia		Spain/ Portugal		UK	
Customer-oriented applications	I	P	I	P	I	P	I	P	I	P	I	P	I	P
Marketing	33	28	20	36	35	32	34	19	44	22	10	38	37	31
Sales	15	23	16	30	15	36	25	13	31	31	8	31	23	19
Customer invoicing/ collection of payment	2	8	8	13	1	13	13	13	29	23	3	18	8	13
Online supply to customers	8	25	10	21	8	19	13	19	19	22	3	33	13	17
Customer support	15	18	14	35	23	34	19	31	13	41	8	31	15	23
Customer monitoring and relationship development	10	21	10	23	11	25	19	19	7	27	8	23	16	16
Recruitment of marketing/sales staff	12	10	8	13	13	8	16	6	38	13	8	13	15	4
Supplier-oriented applications														
Accessing/surfing web sites of possible suppliers to make purchasing decisions	12	15	9	14	18	17	19	6	22	22	10	23	20	20
Purchasing commitments	7	18	14	9	10	24	6	6	22	19	10	15	15	15
Receiving purchases electronically or receiving confirmation of delivery details	8	18	12	12	6	25	13	9	28	16	10	23	13	17
Receiving after-sales support from supplier	8	17	8	15	10	23	9	13	19	16	3	18	17	11
Recruitment of non-marketing/sales staff	2	10	5	5	1	12	13	9	16	16	5	8	7	17
Receiving & responding to supplier requests for info & opinions from you as a customer	10	20	8	17	10	26	13	3	22	16	5	18	13	15
Payment of suppliers	7	8	8	9	4	8	6	6	13	13	3	5	9	8

I = Installed (1998);
P = Plan to install

All figures shown are percentages

Base: E-commerce users/ planned users – Benelux 58-60 respondents; France 62-65; Germany 92-93; Italy 31-32; Scandinavia 30-32; Spain/Portugal 39; UK 74-75

Note: Selected countries only shown

Customer-oriented applications	Finance I	Finance P	Utilities I	Utilities P	Retail/ wholesale I	Retail/ wholesale P	Transport/ travel I	Transport/ travel P	Manufac-turing I	Manufac-turing P	Business services I	Business services P	Other services I	Other services P
Marketing	35	30	17	40	30	34	19	21	33	30	50	24	26	39
Sales	21	21	9	26	16	42	9	11	20	28	28	22	20	30
Customer invoicing/ collection of payment	7	12	6	13	2	25	8	11	10	14	7	11	8	11
Online supply to customers	12	23	4	19	8	33	8	15	10	22	13	22	13	15
Customer support	26	28	9	34	15	31	15	23	13	30	22	24	12	37
Customer monitoring and relationship development	14	23	7	24	7	29	13	13	12	25	11	18	15	27
Recruitment of marketing/sales staff	17	7	9	11	13	16	6	4	14	12	20	2	15	10
Supplier-oriented applications														
Accessing/surfing web sites of possible suppliers to make purchasing decisions	5	16	23	23	17	30	8	6	21	17	15	17	13	8
Purchasing commitments	5	14	17	26	15	25	11	8	9	19	20	17	11	7
Receiving purchases electronically or receiving confirmation of delivery details	2	21	21	26	12	35	13	6	13	20	15	11	8	13
Receiving after-sales support from supplier	5	14	17	28	10	29	8	8	12	14	13	15	8	16
Recruitment of non-marketing/sales staff	2	7	4	13	5	20	2	6	5	14	11	9	3	5
Receiving & responding to supplier requests for info & opinions from you as a customer	5	19	17	32	6	33	9	9	10	20	15	7	11	13
Payment of suppliers	5	2	9	13	8	12	4	6	8	10	11	0	3	7

Table 8
Current and future penetration of E-commerce applications (by sector)

I = Installed (1998); P = Plan to install

All figures shown are percentages

Base: E-commerce users/ planned users – finance 42-43 respondents; utilities 46-47; retail/wholesale 81-84; transport/travel 52-53; manufacturing 84-86; business services 44-46; other services 59-61

An E-commerce application implies that the user uses client and/or server software which is locally or remotely installed. For example, a marketing or sales application will normally be locally installed, as opposed to purchasing, which will normally use a remote supplier-based application.

As *Figure 11* shows, marketing applications are the most widely installed type of E-commerce applications, with 30% of the total sample of E-commerce users/planned users having installed such applications by 1998. A further 31% of businesses are planning such applications, putting marketing ahead of the next most widely-planned applications, customer support and sales, which, in any case, are starting from much smaller installed bases.

Figure 11 also shows that businesses are generally more advanced in installing or planning E-commerce applications to support customer-facing applications than they are in installing or planning equivalent applications to support supplier trading relationships *(Figure 12)*. This may be because, as existing E-commerce users or users-to-be, they are technologically more advanced than their suppliers, many of which may be smaller in the value chain than the organisations' customers, and therefore lacking in an equivalent capability to support E-commerce at present.

Tables 7 and *8* show the percentages of applications installed and planned to be installed by country and by industry sector.

3.4.1. Marketing applications

Note: All figures are for E-commerce users/ planned users

In 1998, the average penetration of marketing applications amongst current/planned E-commerce users is 30%, with a further 31% of businesses planning to install such applications. Scandinavia has the highest installed base of marketing applications, with 44% of businesses having such applications in place, ahead of the UK, which ranks next with 37% of businesses *(Table 7)*. Only 10% of companies in Spain/ Portugal say they have marketing applications, although a large proportion of companies in Spain/Portugal are planning to install such applications. France is significantly behind Germany, which, in turn, is close behind the UK.

Taking an industry sector view, business services companies are most likely to have marketing applications, whereas the transport/travel and utilities categories trail in the use of such applications. While very significant growth is expected in the use of marketing applications in the utilities sector, penetration in the transport/travel sector looks likely to remain low, with the proportion of businesses planning to install such applications being lower than for other industry sectors *(Table 8)*.

Case study: Buckingham Gate: successful marketing over the Internet [www.buckinghamgate.com]

Buckingham Gate, a cybermall jointly developed by ICL and National Westminster Bank, owes its Internet success to a market focus on high quality British brands. As a result, it has recently attracted Rolls-Royce and Wedgwood to its site, joining existing suppliers such as Church's shoes, Tyrone Crystal, Arthur Price and Penhaligons perfumes (note that Rolls-Royce sells luxury accessories with the RR brand via Buckingham Gate). In order to maintain the site's exclusivity, the owners plan to limit it to 20 companies with the "right" brand image: they turn away the majority of retailer approaches.

Buckingham Gate supports both marketing and sales applications. The average Buckingham Gate purchase is over £ 100 (ECU 142), and the most expensive item for sale on the site is around £ 4,000 (ECU 5,683). Since the site opened in late 1995, it has received 9 million hits, or between 12,000 and 20,000 hits a day, from 120 countries, although its main target markets are the USA and Japan. Buckingham Gate tries to count unique accesses, although *this is impossible when customers connect via corporate networks. As a result, it believes the 500-750 unique accesses it counts a day under-estimates the real number.*

Strong sales in Germany and Australia mean that Buckingham Gate will shortly add support for payment in those countries' currencies, as well as support for the Euro and the lira. The sales conversion rate varies from retailer to retailer, but averages 5-6%.

A key marketing activity is the provision of feature articles on the site about Britain, the retailers themselves, events of topical interest, such as Wimbledon, and the Royal Family. Such articles encourage site revisits and the promotion of the Buckingham Gate image.

3.4.2. Sales order and invoicing/ payment applications

Note: All figures are for E-commerce users/ planned users

In the sales applications category, we include receipt of orders from customers and invoicing collection or payment applications, both of which may well be carried out in 1998 using EDI over private networks. Penetration here is much lower than for marketing applications, however, with an average penetration of 17% for sales (orders from customers) and 7% for customer invoicing/payment.

Sales order

Scandinavia is most advanced in Europe in terms of its installed base of sales applications, followed by Italy and the UK *(Table 7)*. Datamonitor puts Italy third in Europe in terms of growth in E-commerce solutions spend and its lead in establishing E-commerce applications suggests that Italian companies are investing in state-of-the-art E-commerce solutions capable of supporting all aspects of E-commerce. The example of Sunglasses International (see page 193) indicates the presence of entrepreneurial companies within Italy with products that adapt well to sales over the Internet.

While Germany has a much lower installed base than the UK in 1998, a high proportion of businesses intend to install such applications, which will allow it to outstrip the UK. In addition, it looks probable that France will also overtake the UK, with the proportion of French companies intending to install sales applications being far higher than the proportion of UK businesses which intend to do so. Spain/Portugal will catch up with Italy, but Scandinavia will continue to lead Europe, with the second highest proportion of planned users of sales applications (after Germany).

Business services leads all other sectors in installed sales applications, but retail/wholesale is likely to demonstrate the greatest overall growth, with 42% of businesses in this sector planning to implement such applications *(Table 8)*. As was the case with marketing applications, utilities and transport/travel companies are the least likely to have marketing applications installed, though, again, a high proportion of utilities companies intend to install such applications.

Customer invoicing/payment

In terms of customer invoicing and payment, Scandinavia dominates *(Table 7)* with a very high penetration level of 29% – its nearest rivals in terms of penetration are Italy (which is still far behind Scandinavia at 13%) and both the UK and France (8%). Again, Spain/Portugal is in catch-up mode with Italy, and France, too, with its EDI heritage, indicates equivalent growth to the UK, while Germany and Benelux lag behind. From a sectoral perspective *(Table 8)* retail/wholesale and manufacturing companies show strong planned growth, suggesting that E-commerce will make further inroads into the supply chain.

The proportion of sales through E-commerce is significant in relation to total sales for a quarter (26%) of businesses which currently have E-commerce applications in the area of marketing/selling to customers. Amongst those 38 respondents that regarded E-commerce sales as being significant, it can be seen that 13 of these are doing very small amounts of business (1-10%), while a further 13 are receiving between 21-30% of sales revenues by electronic means *(Figure 13)*.

Case study: Sunglasses International: successful sales over the Internet

The Rome-based optician's business, Ottica Meloni, launched a web site to sell its designer collection of eyewear in September 1996. Almost immediately, it realised it had hit upon a market opportunity, due to the excellent response to its site. Since 1996, it has changed its name to Sunglasses International, to gain name recognition and to give itself a more international image: it believes it is currently the largest supplier of fashion sunglasses on the Internet.

The company is now a partnership between Ottica Meloni and a UK company which hosts and markets the Sunglasses International site. As business expanded, Ottica Meloni, which is a small family firm, needed a partner to help it manage the Internet sales channel and the site maintenance. Internet sales are directed only at overseas customers and are operated separately from the rest of the business.

In 1997, Sunglasses International carried out around ECU 100,000 worth of business over the Internet, and expects this to reach ECU 150,000 in 1998. However, it is also talking to a new supplier about orders that could triple this amount of revenue. Three quarters of its orders come from the USA, where its site is mirrored in the leading Internet fashion mall, fashionmall.com. The average number of hits the site received in a six-month period between March 1998 and August 1998 was 724,763.

3.4.3. Post-sales and recruitment applications

Note: All figures are for E-commerce users/ planned users

The post-sales category includes online supply to customers; customer support applications, and customer relationship monitoring and development. Average penetration levels for these applications across the European businesses surveyed are: 10%, 16% and 11% respectively.

Online supply

Scandinavia (19% penetration), followed by Italy (13%) and the UK (13%), leads with online supply applications: that is, these businesses either deliver electronically, for example, software upgrades/information/reservations and other online services, or they provide delivery tracking information. Current and future penetration rates of online supply applications are similar in France and Germany *(Table 7)*.

Business services (13%), other services (13%) and finance businesses (12%), not surprisingly, lead in existing applications *(Table 8)*: all three sectors supply information-based services which are easily delivered electronically.

In terms of site size, it is the largest sites (500 plus employees) which show the highest propensity either to have currently installed or plan to install online supply applications.

Customer support

Germany leads in installed customer support applications (23% of businesses), ahead of Italy with 19% of businesses. Both countries have significant plans to install *(Table 7)*, as do Scandinavia and France, which will quickly outstrip the UK.

In terms of sectors, finance demonstrates the greatest commitment to customer support, with utilities the least, though a high proportion of utilities companies do plan to install such applications *(Table 8)*.

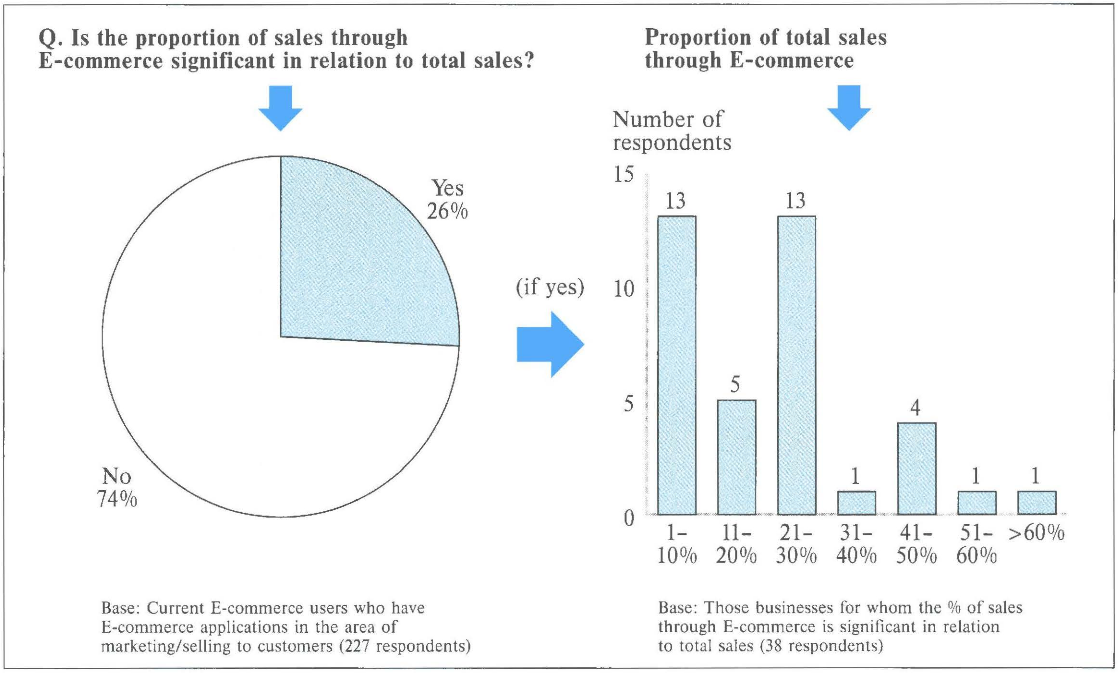


Figure 13
Proportion of total sales through E-commerce

Customer monitoring and relationship development

Italy and the UK are the most advanced in terms of customer monitoring and relationship development applications, with Scandinavia again lagging in the introduction of post-sales applications *(Table 7)*.

The other services sector shows itself most advanced in relationship development, while sectors that are supposedly trying to become customer-oriented, such as utilities and retail/wholesale, lagged all the other sectors. However, retail/wholesale has the highest proportion of companies planning to install *(Table 8)*. Business services will lag many other sectors in the implementation of customer monitoring and relationship development applications, an interesting finding in the light of the fact that it is the sector with the lowest proportion of continuous relationships with customers *(Figure 15)*.

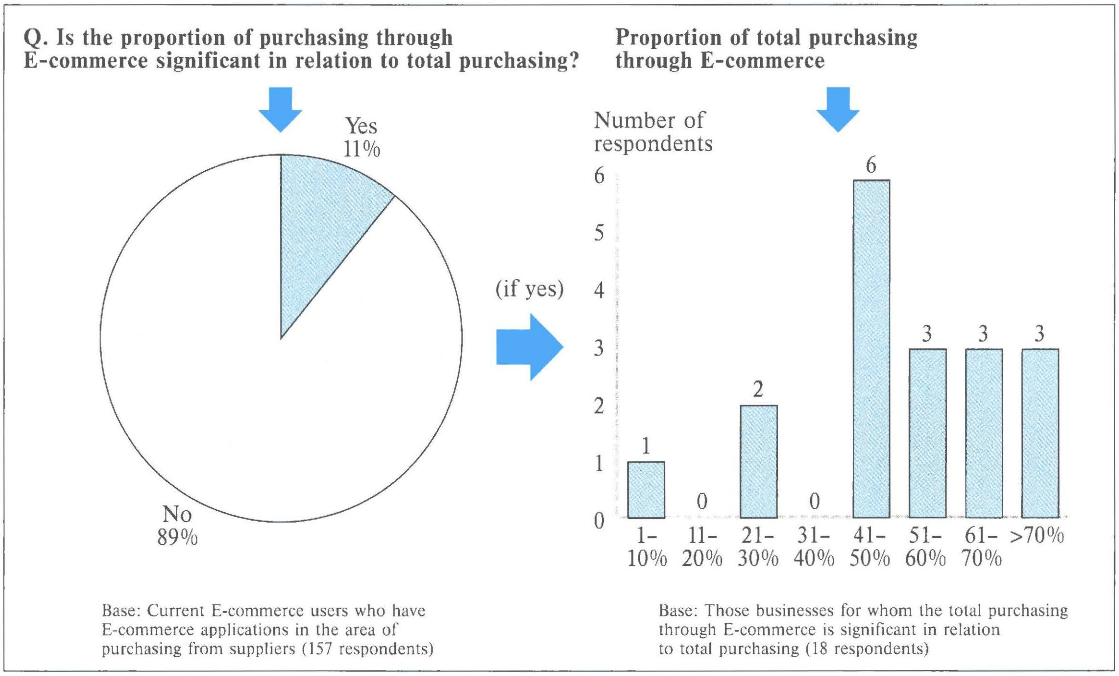
Recruitment of marketing/sales staff

The average penetration rate for recruitment of marketing/sales staff – 14% – is skewed by the very large percentage of businesses in Scandinavia (38%) who said they did this. Although other countries have different penetration levels, once planned recruitment applications are taken into account, only around 20% of businesses in these countries will carry out online recruitment, compared to approximately 50% in Scandinavia *(Table 7)*.

Business services currently have the highest penetration levels, but retail/wholesale has the highest planned growth *(Table 8)*.

There is a very clear correlation between site size (number of employees) and the usage of online recruitment of marketing/sales staff – the larger the site, the more likely it is either to

Figure 14
Proportion of total purchasing through E-commerce



undertake currently or plan to carry out online recruitment of marketing/sales staff. For instance, 21% of sites with 500 plus employees currently make use of online recruitment of marketing/sales staff and 10% plan to do so, whilst at the opposite end of the scale, only 8% of sites with less than 100 employees currently make use of online recruitment and just 4% intend to do so.

Non-marketing/sales staff

Business services also leads the way in electronic recruitment of non-marketing/sales staff (11% penetration), with penetration rates of such applications in other countries being 5% or less *(Table 8)*. From a country perspective, Scandinavia, Italy and the UK are least resistant, with France the least interested *(Table 7)*.

In terms of site size, the largest size sites (500 plus employees) are the most interested in electronic recruitment of non-marketing/sales staff (7% currently do so – 15% intend to).

3.4.4. Purchasing applications

Note: All figures are for E-commerce users/ planned users

This category of applications includes:

- online information searching for suppliers;
- purchase ordering;
- receiving purchases electronically, or receiving confirmation of delivery details;
- receiving after-sales support from suppliers;
- receiving/responding to supplier relationship development requests;
- payment of suppliers.

11% of those businesses which have purchasing applications in place regard the proportion of purchasing they conduct through E-commerce to be significant (in relation to their total purchasing). Of those that regarded the proportion as significant, the greater majority conduct over 40% of their purchasing through E-commerce *(Figure 14)*.

Online information searching

Businesses in Scandinavia, the UK, Italy and Germany are much more likely than their counterparts in Benelux, France and Spain/Portugal to go to supplier web sites to gather information *(Table 7)*.

Few travel companies, with strong links to suppliers through alternative channels, do not use, or intend to use the Web as a means of gathering supplier information, while utilities and retail/wholesale businesses indicate a considerable interest in using the Internet to find alternative sources of supply *(Table 8)*.

Purchase ordering

Overall penetration amongst European businesses for purchase ordering applications is low (13%), possibly due to the technological immaturity of smaller suppliers in the value chain, to which such orders would be sent.

Italian companies came out strongly against sending suppliers electronic purchase orders, while Scandinavia and Germany had the greatest proportion of companies with plans to install *(Table 7)*. Utilities and retail/wholesale companies show themselves once more to be advanced in purchasing applications development *(Table 8)*.

Receiving purchases electronically/ electronic delivery information

European businesses could be termed to be relatively enthusiastic about receiving purchases electronically or delivery confirmation about purchases. At present, Scandinavian businesses are by far the most likely to have such applications installed, whilst German and Spanish/Portuguese businesses seem particularly interested in putting such applications in place in the future *(Table 7)*.

Utilities and retail/wholesale companies again show the most interest in streamlining their supply chains through the use of these applications, with just under 50% of companies in these sectors either having already installed or planning to install such applications *(Table 8)*.

Receiving after-sales support

Scandinavia leads in receiving after-sales support electronically, but Germany has the strongest plans in this application category, perhaps not surprisingly since Germany also leads in the provision of customer support applications. The UK has the second highest installed base in terms of current penetration *(Table 7)*.

The finance sector, though committed to providing after-sales support, is not concerned with receiving it, while utilities and retail/wholesale companies plan aggressive growth in this application area *(Table 8)*.

Responding to supplier requests

Not surprisingly, when most companies have not yet installed their own customer relationship monitoring applications, the proportion that currently have formal electronic mechanisms in place to respond to their suppliers is relatively low (11%). Italy and UK, leaders in installed customer relationship monitoring applications, are currently among the most responsive to suppliers, although Scandinavia has a considerably higher penetration rate. Italy will see minimal growth in this area, however, while the UK will be outstripped by Germany and Benelux *(Table 7)*.

The finance sector, a strong acquirer of customer information, is least willing to give equivalent information away, while utilities and retail look set to become the most co-operative *(Table 8)*.

Payment of suppliers

The lack of a capability to pay suppliers electronically is striking. Scandinavian companies lead again, but even amongst these businesses, only a quarter either currently have installed, or plan to install this capability. While French and UK businesses show marginally more interest than those in other countries, Germany and Spain/Portugal, which have been relatively enthusiastic about other types of purchasing applications, display a low level of interest in paying electronically *(Table 7)*.

The finance sector shows negligible interest, compared with the utilities, retail/wholesale and manufacturing sectors. However, even in these sectors, only around 20% of businesses have installed, or are planning to install such an application *(Table 8)*.

The strongest findings in terms of the electronic payment of suppliers is by site size. The larger the site (number of employees), the more likely it is to currently pay, or plan to pay suppliers electronically.

3.4.5. Type of E-commerce relationship (continuous or ad hoc)

Figure 15 shows that the majority of organisations with marketing/selling type E-commerce applications installed (62%) enjoy continuous relationships with their customers, but the significant proportion of ad hoc relationships points to the need for cost-effective E-commerce connections with customers, as delivered by the Internet. Continuous customer relationships are most prevalent in the utilities sector, and least in business services: in the latter sector, over 50% of its relationships are ad hoc. In terms of site size, the smaller the site (number of employees), the more likely it is to enjoy continuous relationships with its customers *(Figure A 9 in the Annex)*.

3.4.6. Turnover split between business and consumer end-customers

Of those businesses which have marketing/selling type E-commerce applications installed, on average, 70% of overall turnover is based on business end customers, whilst 30% is based on consumer end customers *(Table 9)*.

4. Readiness for E-commerce

4.1. Motivating factors for E-commerce

The survey finds that the main reason that companies adopt E-commerce is to provide better support for their customers/suppliers, a driver cited by 44% of businesses *(Figure 16)*. This suggests that most organisations' moves into E-commerce are defensive, aimed at business problems such as customer retention, rather than strategic, aimed at capturing new markets and customers.

This is also in line with the finding that, when companies were asked whether or not they were influenced by their competitors in adopting E-commerce, 40% said that they were influenced by their competitors, suggesting a defensive line of action. The vast majority (69%) of this subset of businesses were influenced by existing competitors rather than new entrants into their markets (6%), although a significant proportion (25%) were influenced by both existing and new rivals.

Competition as a motivating factor

In answer to the question, "What caused you to decide to adopt E-commerce?", competition was cited as the second key motivator - 34% of all businesses - and notably by 47% of businesses in the transport/travel sector *(Figure 17)*. However, when analysed by type of organisation, it is clear that organisations that are planning to use E-commerce are far more defensive than existing E-commerce users, which are pioneers in this market. This bears out the observation that leading-edge companies tend to be strategic in outlook compared to followers-on, which typically react to defend their market position. 44% of E-commerce users cite "other" reasons for adopting E-commerce, while 50% of planned users are concerned with better support and 43% are con-

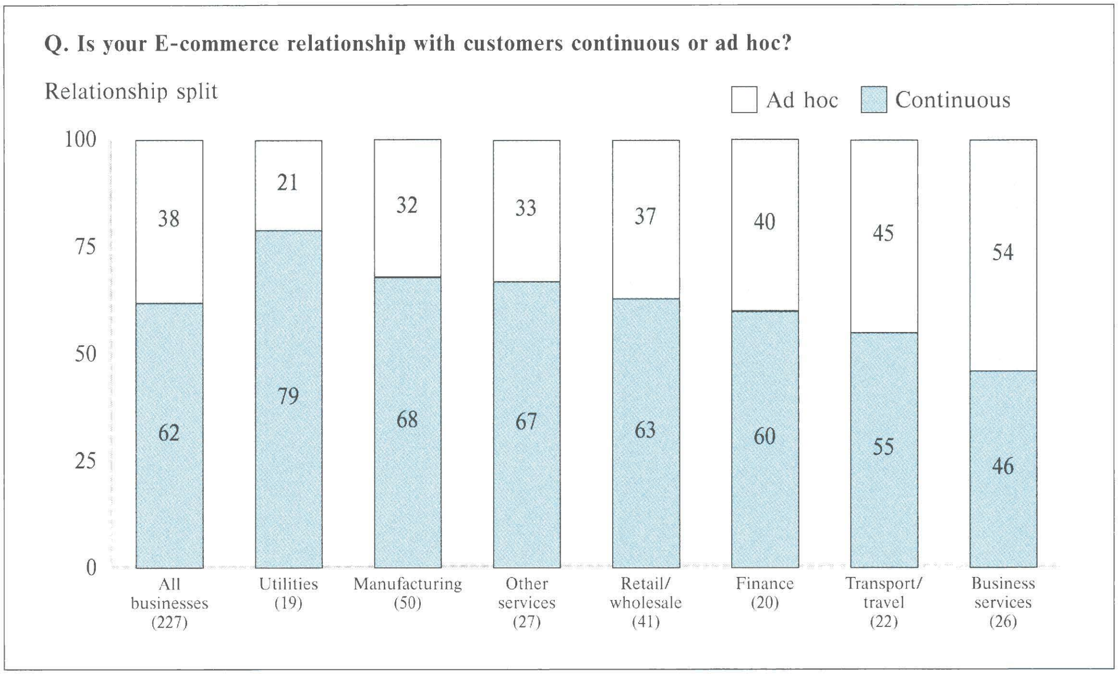


Figure 15
Relationship between businesses with E-commerce and their customers (by sector)

Note: Figures in brackets show number of respondents

Base: E-commerce users who have E-commerce applications in the area of marketing/selling to customers

Table 9
Turnover split between business and consumer end-customers with marketing/selling E-commerce applications (by sector)

Industry sector	% of overall turnover that is based on **business end-customers**	% of overall turnover that is based on **consumer end-customers**
Manufacturing (36)	85	15
Transport/travel (17)	80	20
Retail/wholesale (26)	71	29
Other services (13)	68	32
Finance (13)	63	37
Business services (18)	54	46
Utilities (12)	35	65
All European businesses (145)	**70**	**30**

Note: Figures in brackets show number of respondents

Base: Those businesses which have marketing/selling type E-commerce applications installed

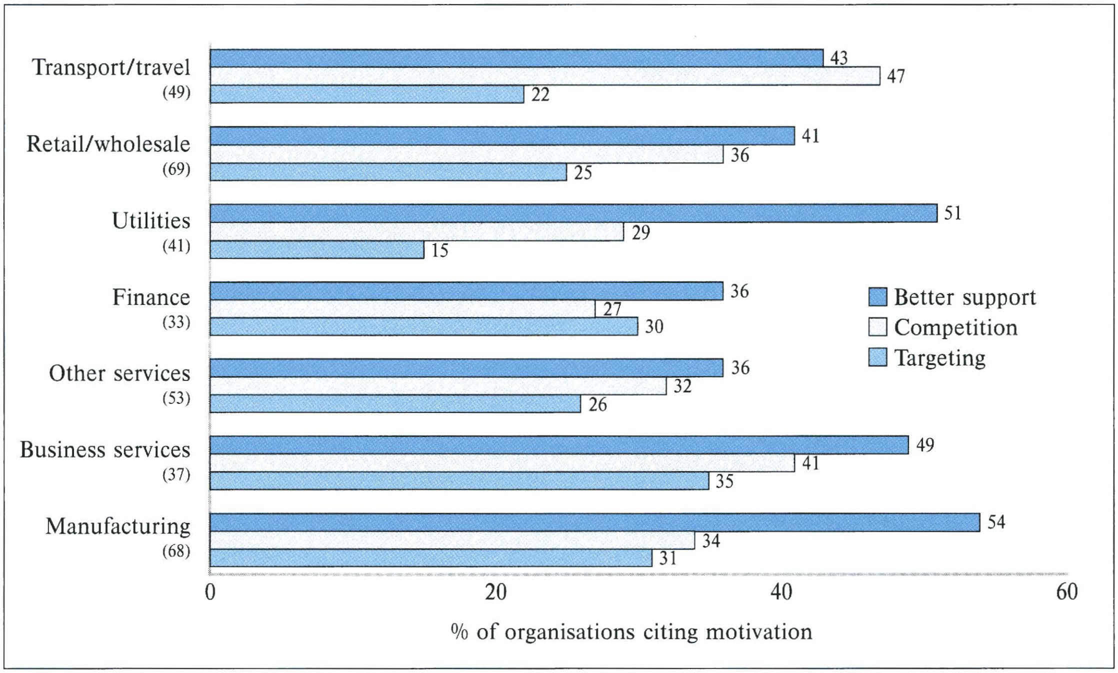
cerned with competition. These figures drop respectively to 42% and 32% among E-commerce users. Other motivating factors cited by businesses included: customer pressure; efficiency; speed (of information access and delivery); organisation image (being perceived as "up-to-date" and fashionable); lower cost of doing business; and for research and development reasons.

A higher proportion (33%) of E-commerce users also appear to have taken a "leap of faith" into E-commerce, or possibly the original reason for adopting EDI, for example, has been lost over the years.

Figure 16
Motivations to adopt E-commerce (all current/planned users)

Base: E-commerce users/planned users (388 respondents)

Figure 17
Motivations to adopt E-commerce (by sector)



Note: Figures in brackets show number of respondents

Base: E-commerce users/planned users

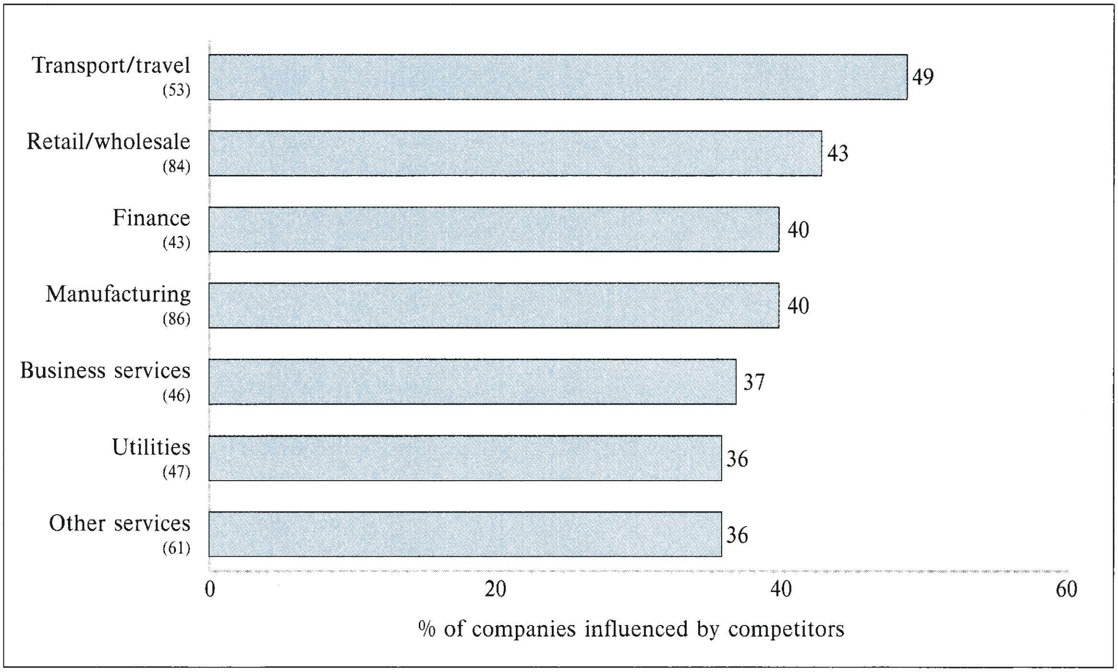


Figure 18
Companies influenced by competitors in their adoption of E-commerce (by sector)

Note: Figures in brackets show number of respondents

Base: E-commerce users/ planned users

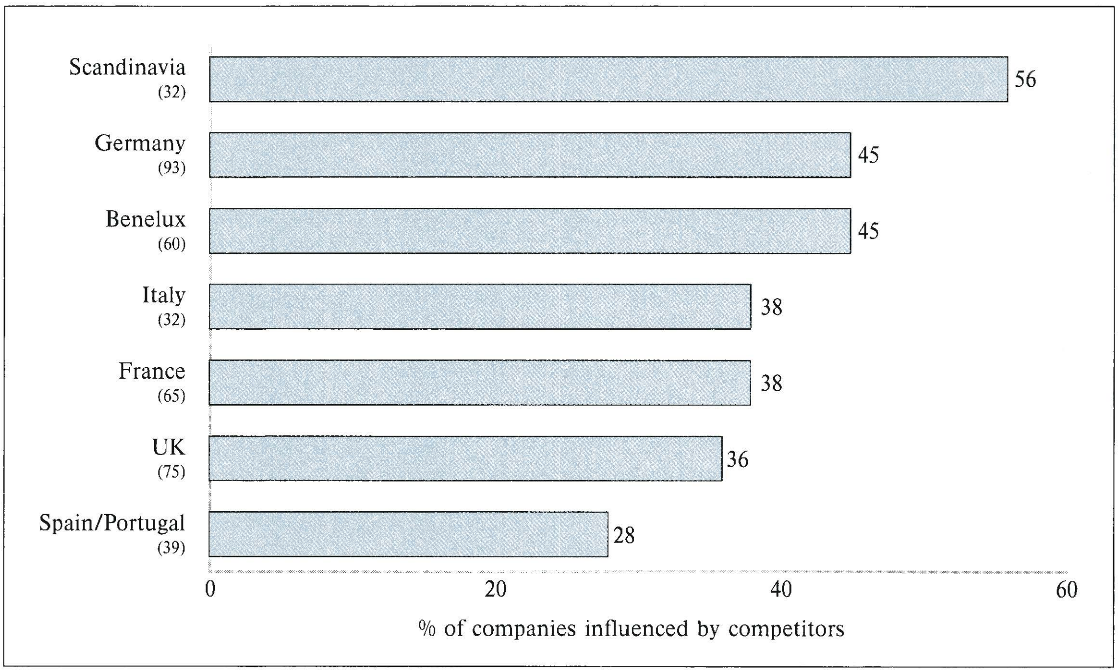
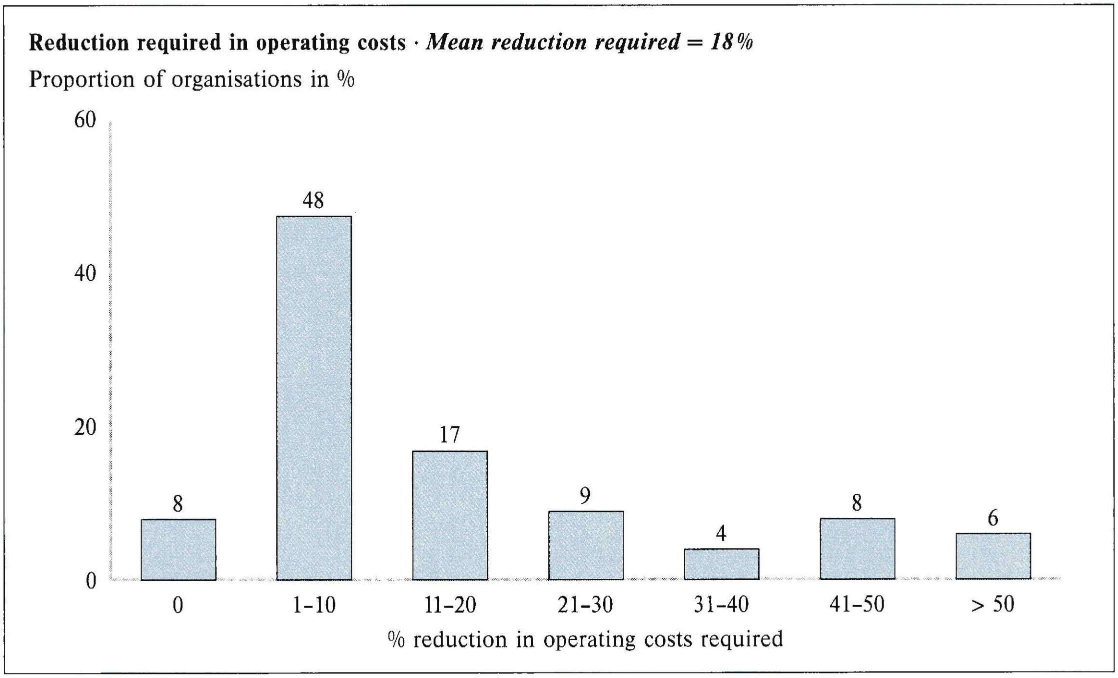


Figure 19
Companies influenced by competitors in their adoption of E-commerce (by country)

Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown

Base: E-commerce users/ planned users

Figure 20
Proportion by which operating costs must be reduced to justify E-commerce



Note: 279 (61%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users (178 respondents)

Companies were specifically asked whether they were influenced in their adoption of E-commerce by their competitors, and if so, whether these were existing or new competitors (or both). By sector, transport/travel companies are the most influenced by competitors in their adoption of E-commerce *(Figure 18)*, a finding that is not surprising, given that this is one of the most advanced and competitive E-commerce markets worldwide.

Of those organisations which stated that they were influenced by competitors, utilities companies were most concerned about new competitors, in reaction to their markets being deregulated across Europe *(Figure A10 in the Annex)*.

Growing competition in certain country/regional E-commerce markets is indicated by the high proportions of Scandinavian, Benelux and German businesses citing competition as a key motivation for adopting E-commerce *(Figure 19)*.

4.2. Financial triggers for E-commerce

4.2.1. Operating costs

The majority of companies (48%) require operating costs to be reduced by between 1% and 10% to justify E-commerce *(Figure 20)*. However, looked at from a sectoral perspective *(Figure 21)*, a high proportion of utilities businesses require operating costs to be reduced by a much larger percentage, so that the mean average reduction required in the utilities sector is 28% (as opposed to the overall average of 18%). A significant proportion of finance businesses also demand large reductions in operating costs, although, overall, the finance sector did not rate reduced operating costs as an important benefit (see section 4.3.). Utilities and business services did, however, bearing out the fact that both sectors are looking for higher savings than other sectors.

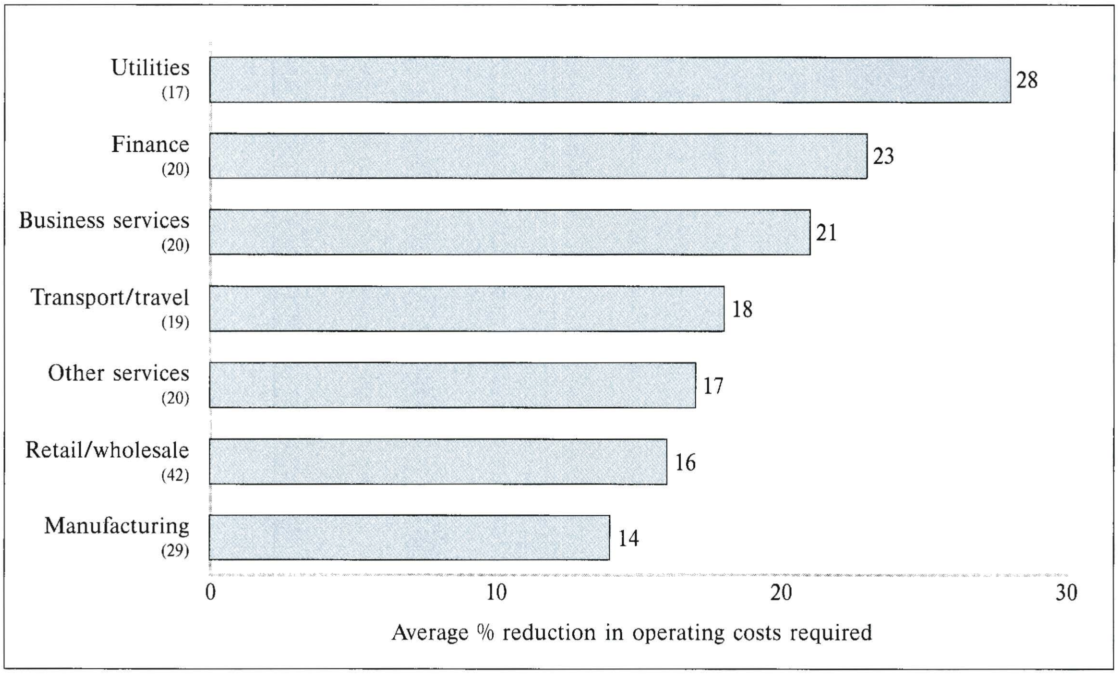


Figure 21
Reduction in operating costs necessary to make E-commerce attractive (by sector)

Note 1: Figures in brackets show number of respondents
Note 2: 279 (61%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

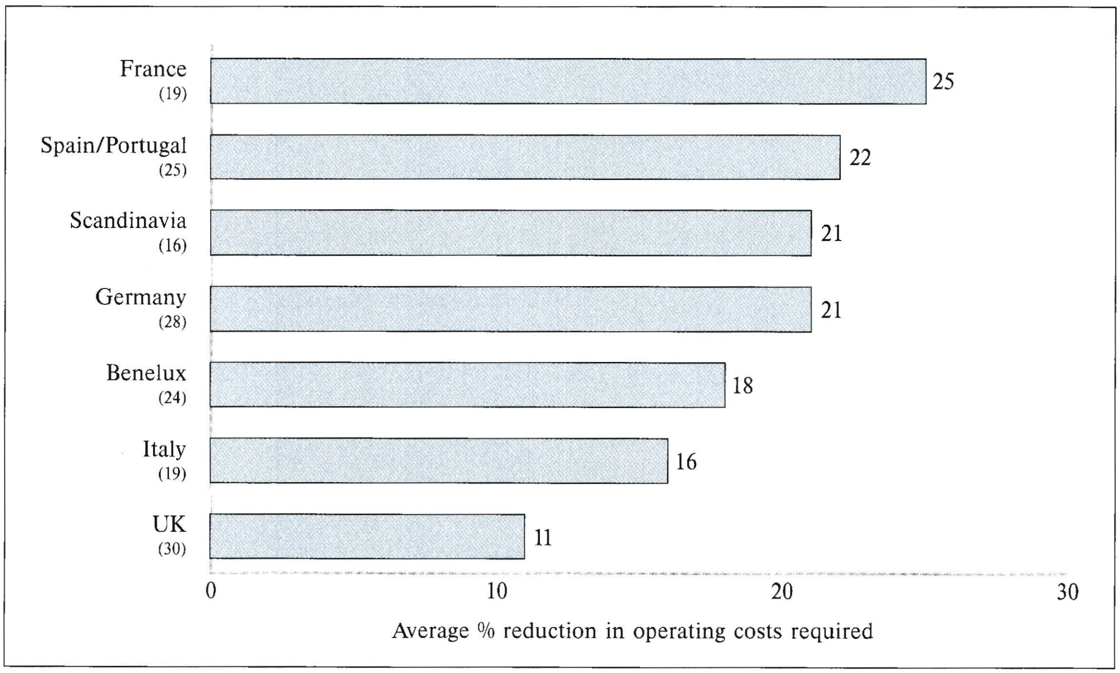
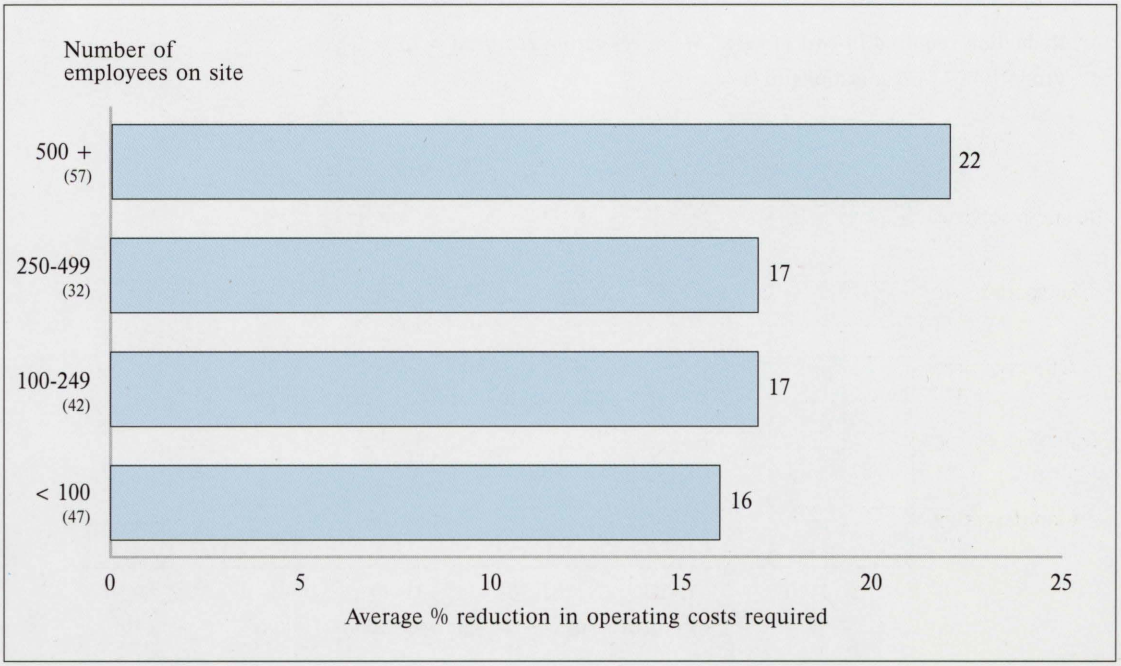


Figure 22
Reduction in operating costs necessary to make E-commerce attractive (by country)

Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown
Note 3: 279 (61%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

Figure 23
Reduction in operating costs necessary to make E-commerce attractive (by site size)



Note 1: Figures in brackets show number of respondents
Note 2: 279 (61%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

French businesses were most interested in achieving large reductions in operating costs, requiring on average a 25% reduction in costs. UK businesses were least interested, suggesting that a higher proportion of businesses in the UK are investing for strategic reasons, rather than for a short-term, quantifiable return on investment *(Figure 22)*.

Large size sites, already identified as the most defensive group, also demand the highest reduction in operating costs among the site size categories *(Figure 23)*.

4.2.2. Cost of sale

The mean percentages reduction required for cost of sale in order to justify E-commerce (15%) is lower than the reduction required for operating costs (18%).

A fifth (20%) of existing and planned E-commerce user companies did not factor reduced costs of sale into their business case for adopting E-commerce, and a further 45% demanded that cost of sale be reduced by between only 1% and 10% *(Figure 24)*. This suggests that the majority of organisations do not anticipate that their customer base will switch to the Internet en masse, thus making cost of sale a critical business benefit.

By sector *(Figure 25)*, utilities are the most interested in reduced cost of sale, followed by finance and business services; manufacturing businesses can be regarded as the least interested.

As was the case for reduced operating costs (see section 4.2.1.), larger sites demand the highest reduction in cost of sale in order to justify E-commerce *(Figure 27)*.

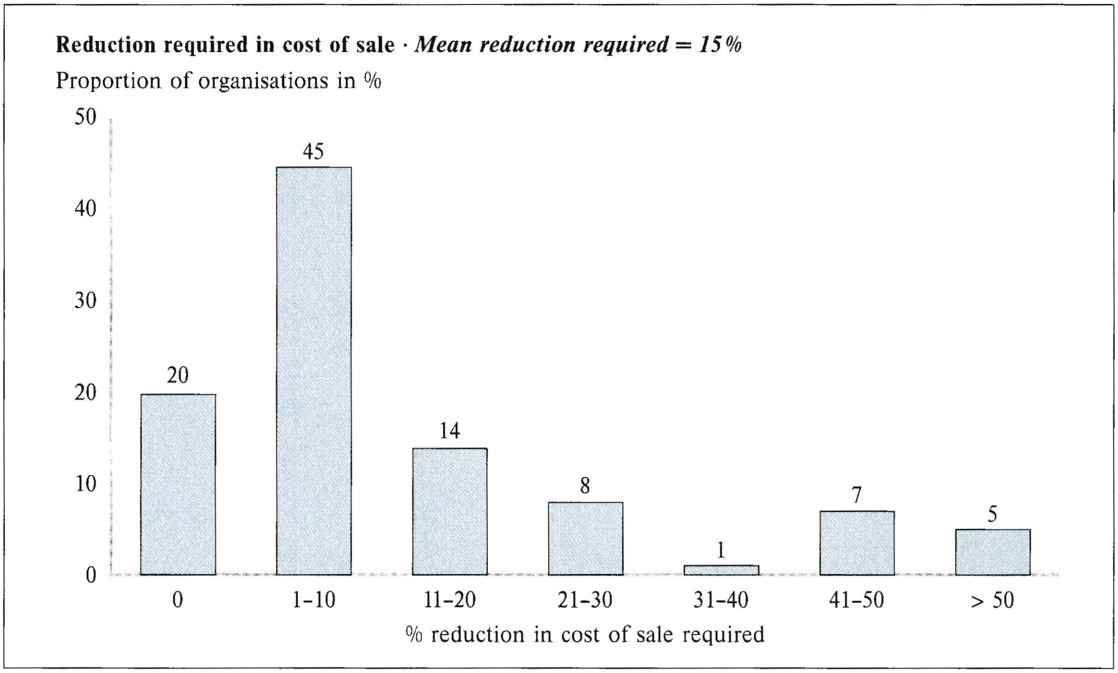


Figure 24
Proportion by which cost of sale must be reduced to justify E-commerce

Note: 275 (60%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users (182 respondents)

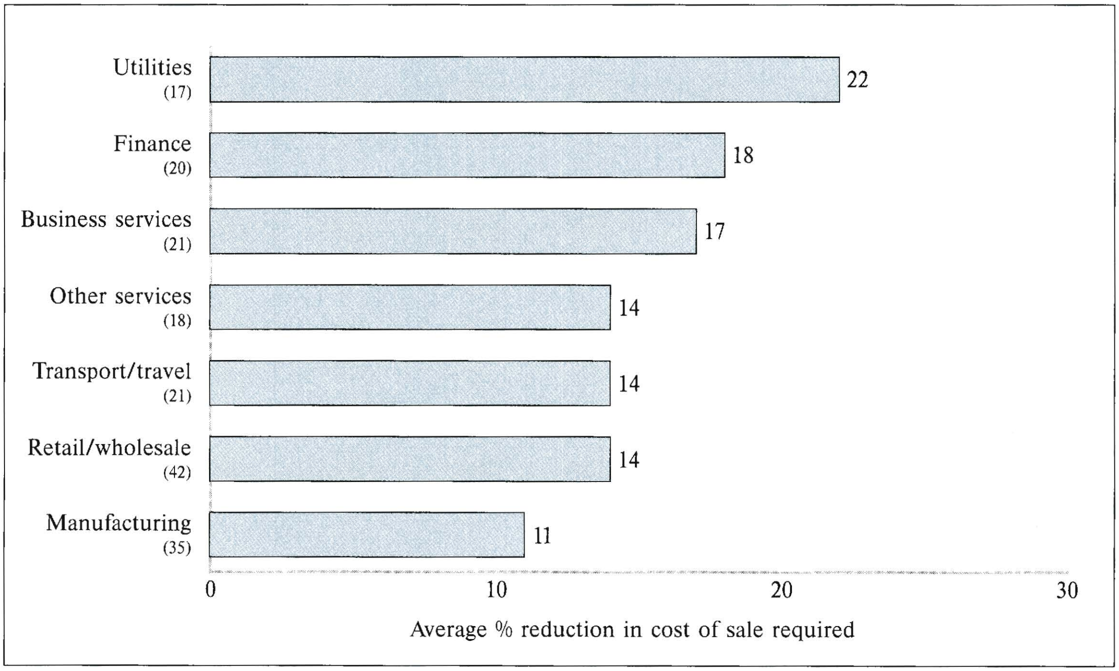
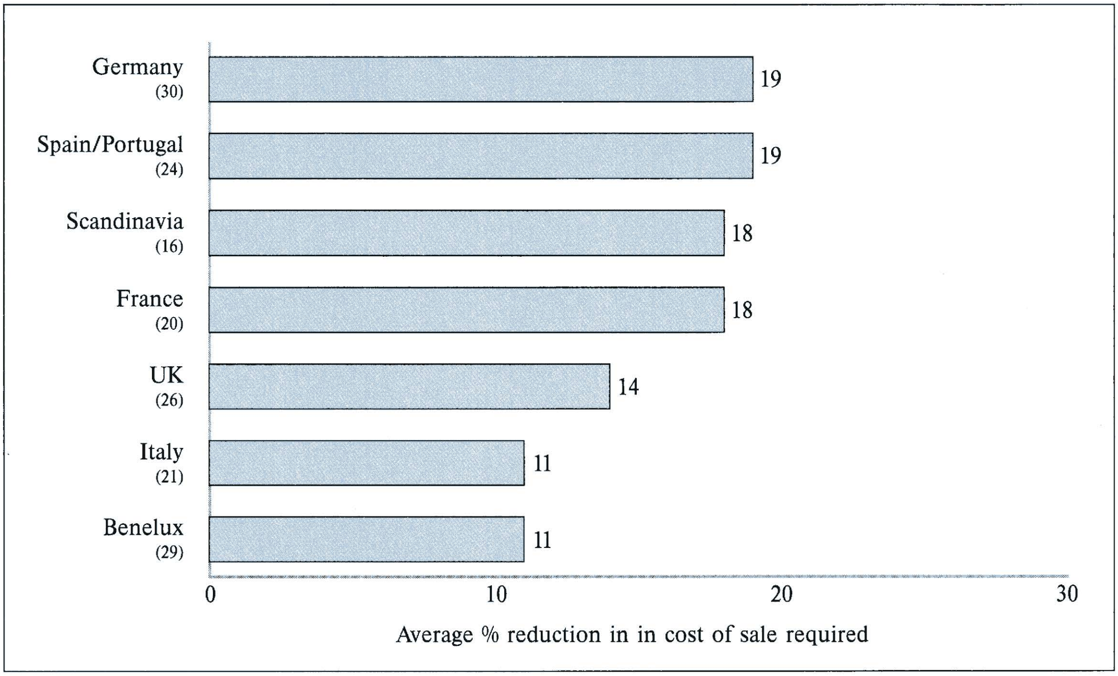


Figure 25
Reduction in cost of sale necessary to make E-commerce attractive (by sector)

Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown
Note 3: 275 (60%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

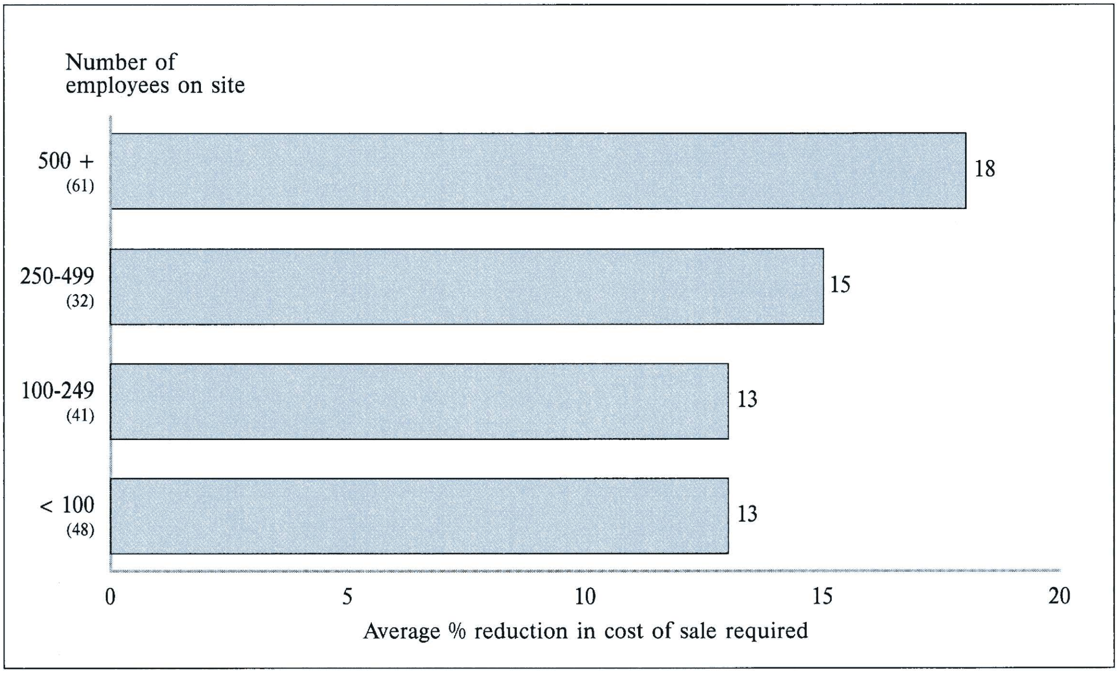
Figure 26
Reduction in cost of sale necessary to make E-commerce attractive (by country)



Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown
Note 3: 275 (60%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

Figure 27
Reduction in cost of sale necessary to make E-commerce attractive (by site size)



Note 1: Figures in brackets show number of respondents
Note 2: 275 (60%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

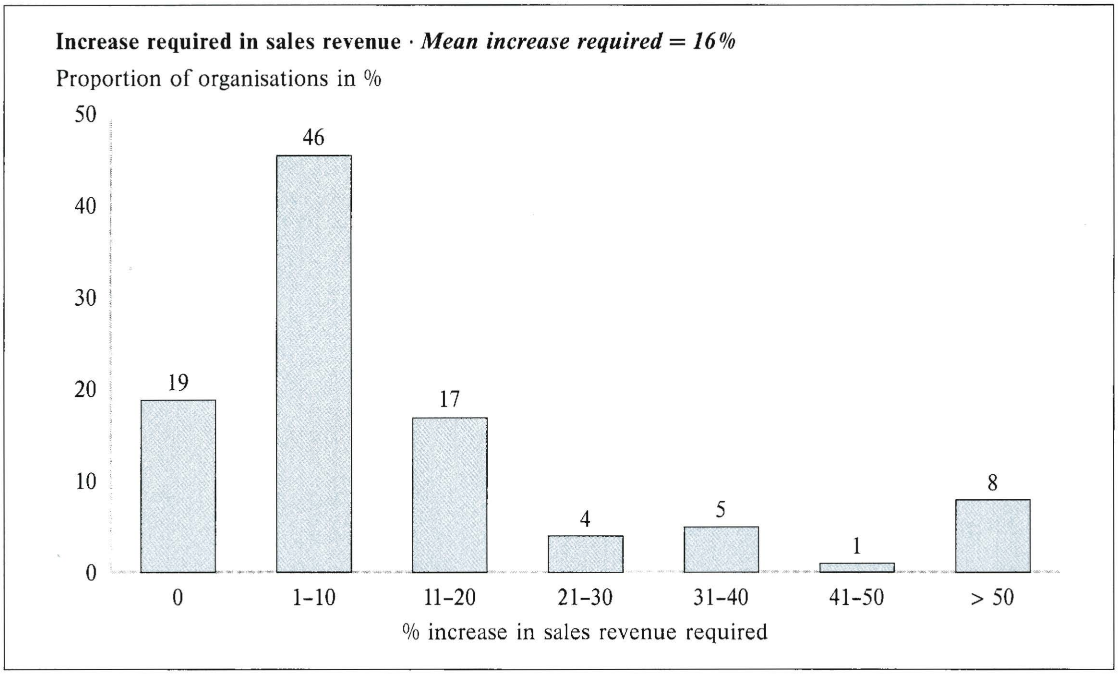


Figure 28
Proportion by which sales revenue must be increased to justify E-commerce

Note: 297 (65%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users (160 respondents)

4.2.3. Increased sales revenue

Supporting the thesis that organisations do not seek immediate returns from increased sales volumes as a result of investing in E-commerce, 19% do not require a rise in sales revenue as a justification for adoption, and a further 46% require sales revenue to increase only by between 1% and 10% *(Figure 28)*. Utilities and business services organisations again appear to be the most demanding – utilities' average percentage is almost 10 points ahead of business services – while finance, manufacturing and other services businesses are the least expectant of increased sales revenue *(Figure 29)*.

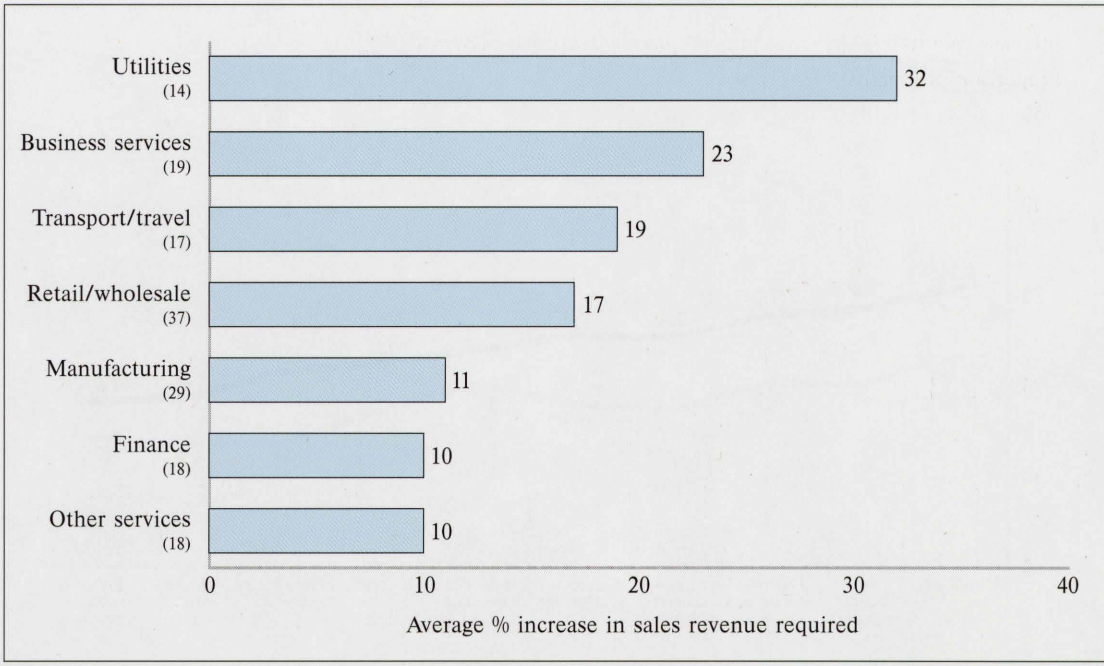
By country, the average increase in sales revenue required to make E-commerce attractive to businesses in Spain/Portugal was 24%, compared, at the other end of the scale, to only 9% in Italy *(Figure 30)*.

4.3. Achieving results

Satisfaction with the results organisations are achieving from E-commerce currently fall well below the level of importance they ascribe to these results. *Figure 31* shows that while quality of customer service is the most important goal of E-commerce for most businesses – fitting with the overall motivation to support customers better – their level of satisfaction falls well short of this goal.

From a whole-survey perspective, all the satisfaction scores are below levels usually considered acceptable (a score of 7.5 and above, in a ranking of 1-10, where 1 is least and 10 is most satisfactory). This suggests that E-commerce is not yet delivering against organisations' expectations. Satisfaction with financial indicators, including reduced cost of purchase, reduced cost of sale and increased sales revenues, is particularly low. Despite forecasts, such as IDC's, that Western European revenues

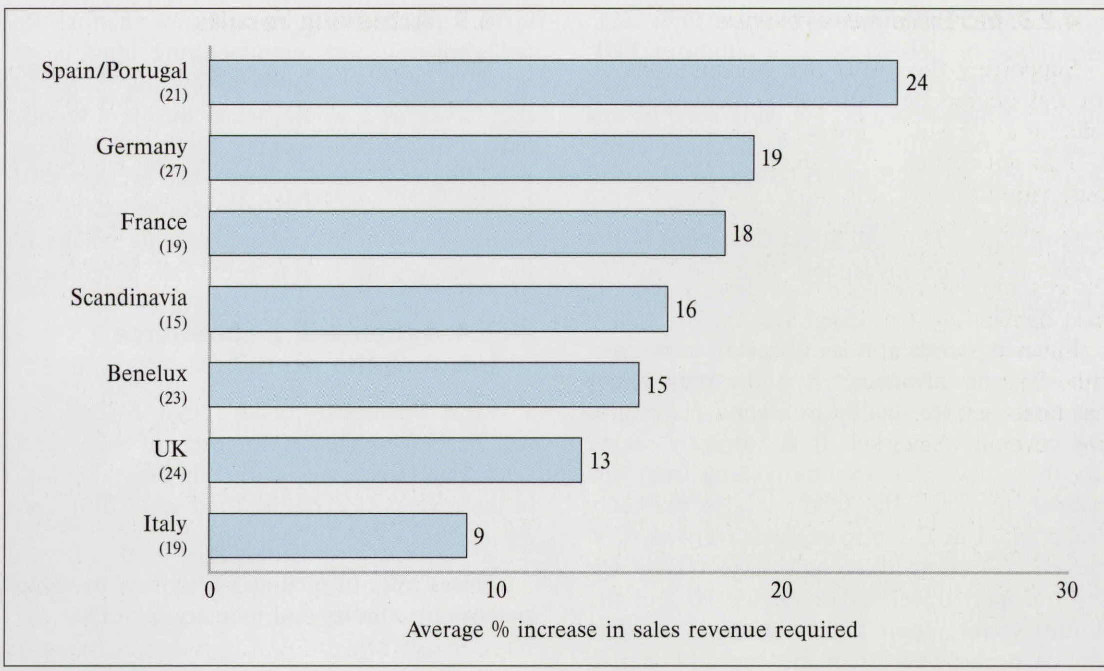
Figure 29
Increase in sales revenue necessary to make E-commerce attractive (by sector)



Note 1: Figures in brackets show number of respondents
Note 2: 297 (65%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

Figure 30
Increase in sales revenue necessary to make E-commerce attractive (by country)



Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown
Note 3: 297 (65%) of the 458 respondents who were asked this question answered "Don't know"

Base: E-commerce users/ planned users

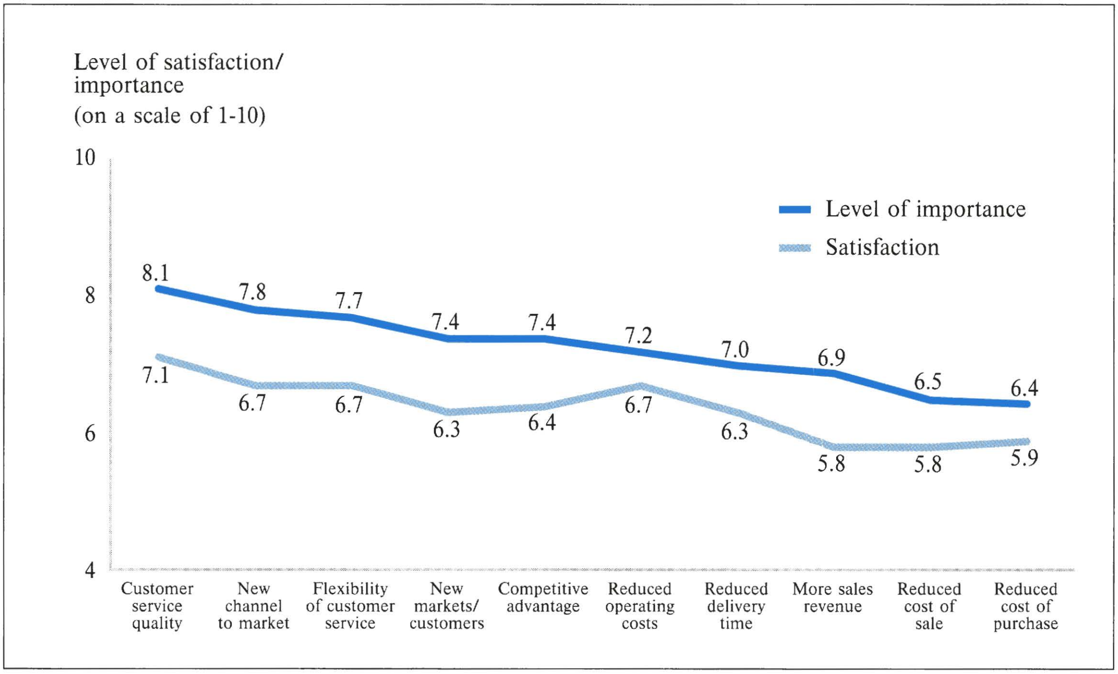


Figure 31
Satisfaction and importance associated with benefits of E-commerce – all European businesses

Note: The majority of respondents (at least 75%) answering these questions were current users

Base: E-commerce users/ planned users (334–433 respondents)

from Internet E-commerce will rise from ECU 900 million in 1997 to ECU 26 billion in 2001, the Romtec survey suggests that a large proportion of businesses are on the early edge of this revenue curve, with revenue-generating applications only installed in 1997/1998, or about to be installed in 1999, and with investment costs to write down. This will affect their view of the current return on investment that E-commerce is bringing.

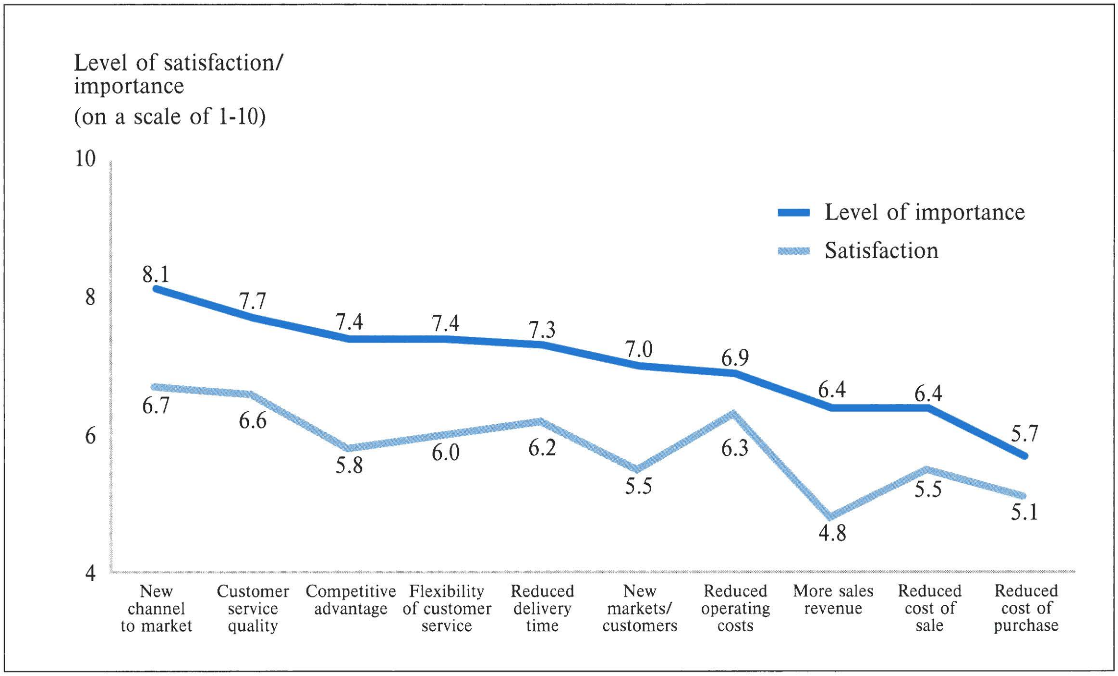
Finance stands out as a sector concerned with strategic advantage: it is the only sector that ranks service quality in second place after new channel to market. It is currently seeing very little new sales revenue coming from this channel, however: the sector is also markedly disappointed in E-commerce's delivery on new markets and competitive advantage *(Figure 32).* The transport/travel sector *(Figure 33)* and the utilities sector report higher levels of satisfaction, particularly against highly-ranked benefits: service quality, flexibility and new channel. Retail/wholesale and manufacturing importance/ satisfaction levels closely follow the scores for the survey as a whole, while business services have a higher-than-average interest in reducing operating costs, and a lower-than-average satisfaction with achieving competitive advantage. *Figures A 12-A 16 in the Annex* provide results for those sectors not shown in the following figures.

4.4. When will E-commerce become the norm?

Most businesses believe that E-commerce will become the norm for each of sales, post-sales, purchasing and marketing functions within three years (i.e. before the end of 2001 – see *Figure 34*).

Please refer to section 5.1. (critical mass) for analysis by country and industry sector.

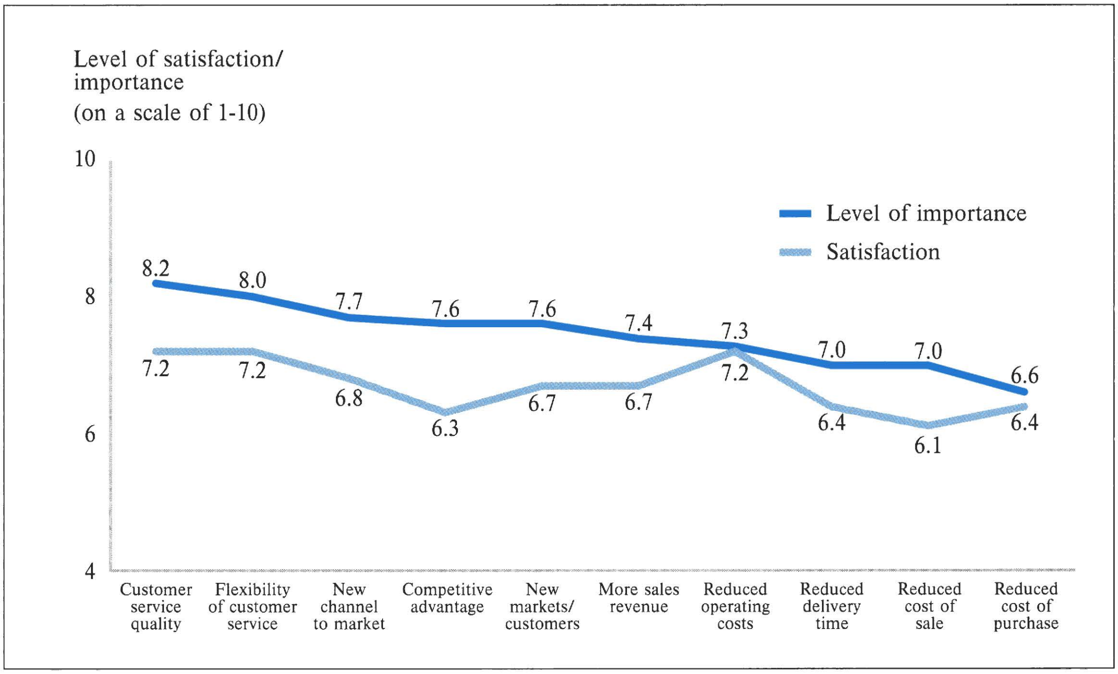
Figure 32
Satisfaction and importance associated with benefits of E-commerce in the finance sector



Note: The majority of respondents (at least 75%) answering these questions were current users

Base: E-commerce users/ planned users in finance sector (19–39 respondents)

Figure 33
Satisfaction and importance associated with benefits of E-commerce in the transport/travel sector



Note: The majority of respondents (at least 75%) answering these questions were current users

Base: E-commerce users/ planned users in transport/travel sector (31–53 respondents)

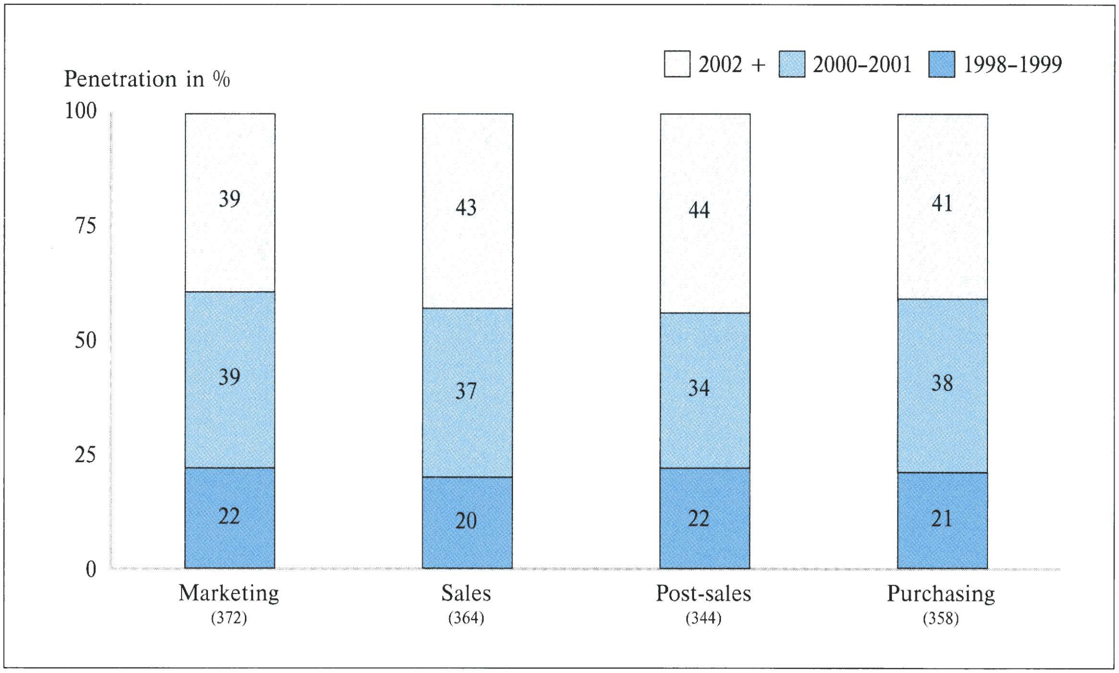


Figure 34
When will E-commerce become the norm?

Note: Figures in brackets show number of respondents

Base: E-commerce users/ planned users

5. Facilitating E-commerce in Europe

This section discusses:

- timescales for achieving a critical mass of E-commerce users across countries and sectors;
- the barriers to adoption that still need to be overcome.

5.1. Achieving critical mass

In Romtec's experience, when 50% of organisations in a particular country or industry sector have adopted a new practice and/or technology, a critical mass can be said to exist for that practice/technology, compelling further adoption by other organisations if they are to remain competitive.

This section indicates when this critical mass point will be reached by application type by the respondent samples in the countries/industry sectors represented in the survey. Critical mass has been ascertained for each of the major E-commerce applications areas by examining when companies expect it to be the norm for businesses in their sector to use each of the E-commerce applications. Although this may be a crude reflection of the picture in the countries/industry sectors as a whole, it is at least indicative of how quickly critical mass might be achieved. Nevertheless, the bias of the question concerning when E-commerce applications will become the norm towards existing E-commerce users and planned users should be taken into account when applying the results more widely. A significant proportion of organisations within countries and sectors will remain highly resistant to E-commerce, as indicated by findings elsewhere in the survey, and this will slow progress towards, and beyond, the critical mass point.

5.1.1. Critical mass for marketing applications by country and sector

For most European countries in the survey, critical mass for marketing applications will arrive in 2001. However, France and Italy look set to reach critical mass point a year earlier, by a narrow margin *(Figure 35).*

All industry sectors will reach critical mass in either 2000 or 2001. Of the industry sectors which will reach critical mass point by 2000, it is utilities which will have surpassed the point by the biggest margin *(Figure 36).*

5.1.2. Critical mass for sales applications by country and sector

France, Italy and Scandinavia expect to have a critical mass point for sales applications in place by 2000, while the UK, Benelux and Germany expect to reach this point a year later *(Figure 37).* Spain/Portugal is the most slow-moving country market, with businesses arriving at critical mass for installed sales applications in 2002.

Critical mass point for sales applications will be achieved in the utilities, manufacturing and business services sectors in 2000, with, once again, utilities proving itself to be the fastest-moving sector, surpassing the critical mass point by a significant degree in 2000 *(Figure 38).* These three industry sectors are likely to have typically a greater business-to-business focus than the finance, retail/wholesale, transport/travel and other services sectors, whose slower expectations of when E-commerce will become the norm for sales applications may reflect their focus on business-to-consumer markets, where sales over the Internet are expected to take off slowly for cultural and cost reasons.

5.1.3. Critical mass for post-sales applications by country and sector

Only Scandinavia will reach critical mass point for post-sales applications before 2001. All other countries, with the exception of Spain/Portugal (2002), will reach critical mass point in 2001 *(Figure 39).*

Utilities and business services, two sectors with a high level of interest in customer service, will be the only industry sectors to reach critical mass for post-sales applications in 2000. All other sectors will reach critical mass in 2001 *(Figure 40).*

5.1.4. Critical mass for purchasing applications by country and sector

It is striking how quickly critical mass for purchasing applications is expected to be reached, given the low levels of implementation and apparent interest in 1998.

Countries will most commonly reach critical mass point for purchasing applications in 2001. However, Germany and Scandinavia will reach critical mass point a year earlier in 2000, whilst Italy trails, with its installed base reaching critical mass in 2002 *(Figure 41).*

In terms of industry sector, the utilities and business services sectors will most quickly reach critical mass point (i.e. in 2000 – see *Figure 42*). Finance bears out the conservatism that has marked its survey responses throughout, being the slowest to reach critical mass point (2002).

5.2. Constraints to E-commerce

A quarter (24%) of those businesses not intending to adopt E-commerce are retaining an observer stance, "waiting to see" whether E-commerce becomes an attractive proposition for their organisation *(Figure 43).* This was the single largest constraint, while only 15% named security as a barrier, 4% privacy, and 8% cost.

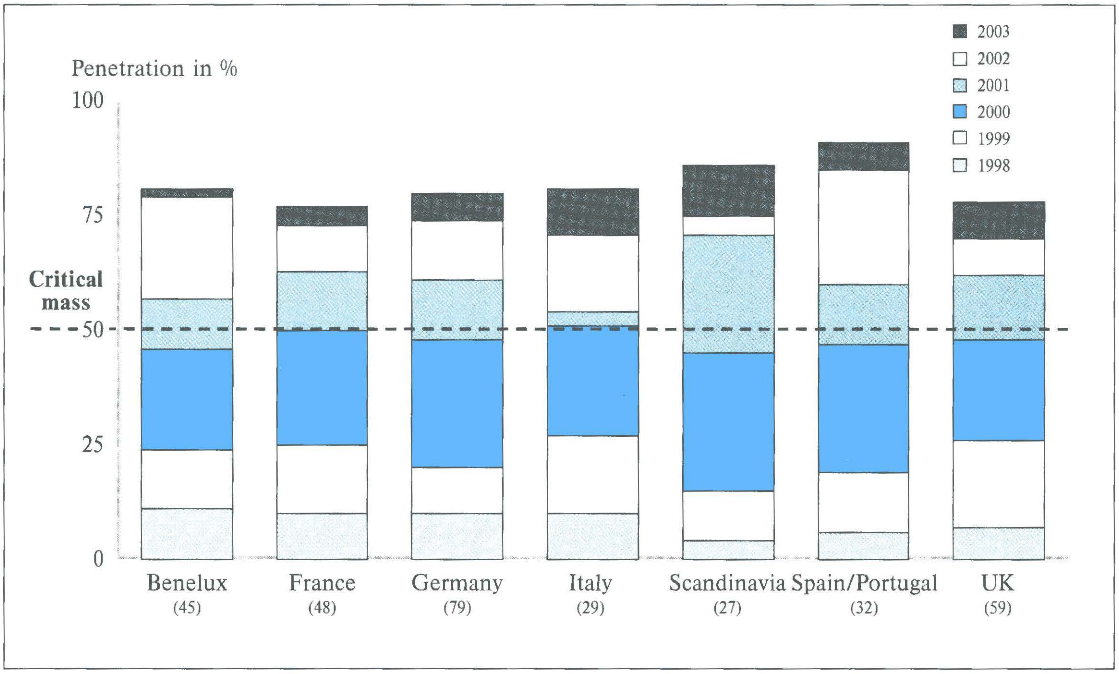


Figure 35
Critical mass for marketing applications (by country)

Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown

Base: E-commerce users/ planned users

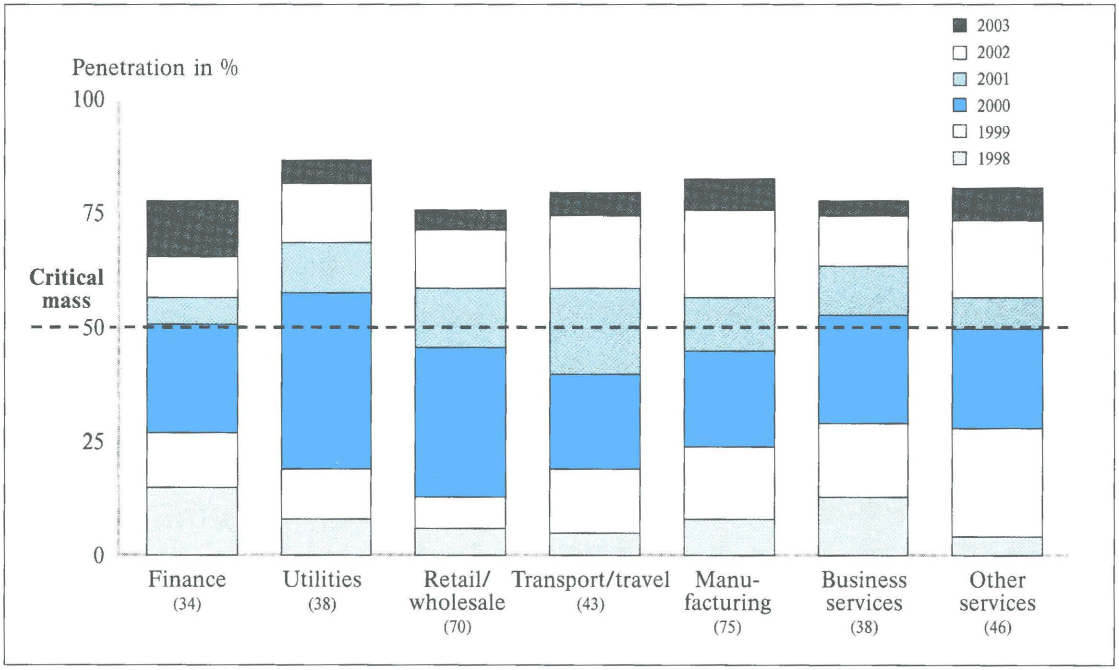
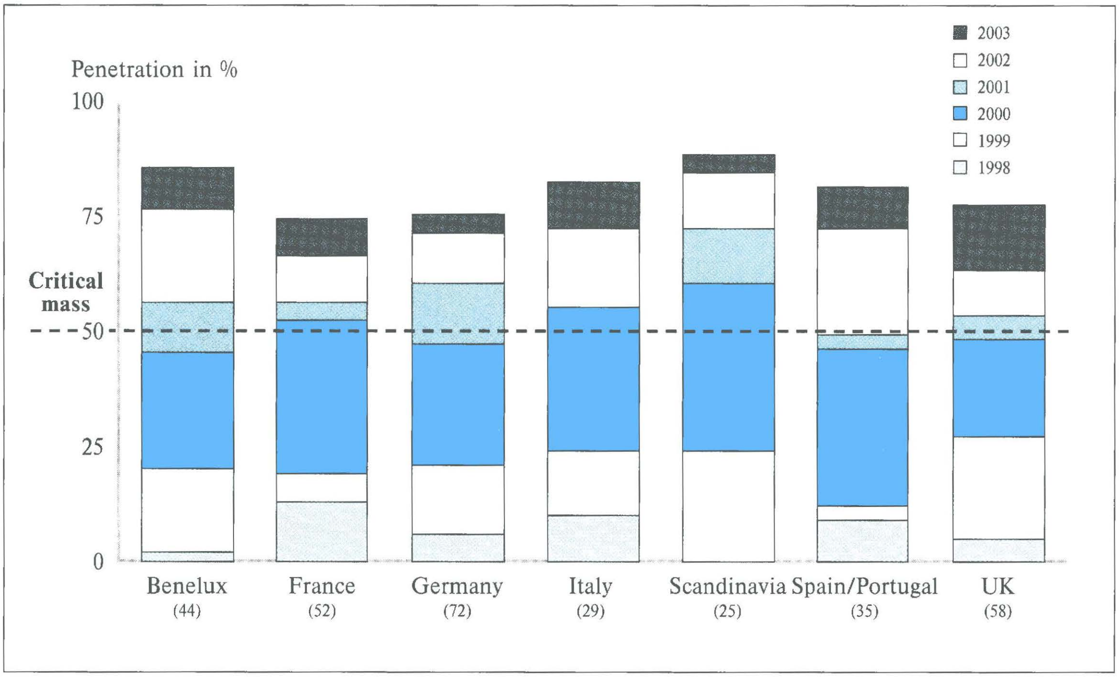


Figure 36
Critical mass for marketing applications (by sector)

Note: Figures in brackets show number of respondents

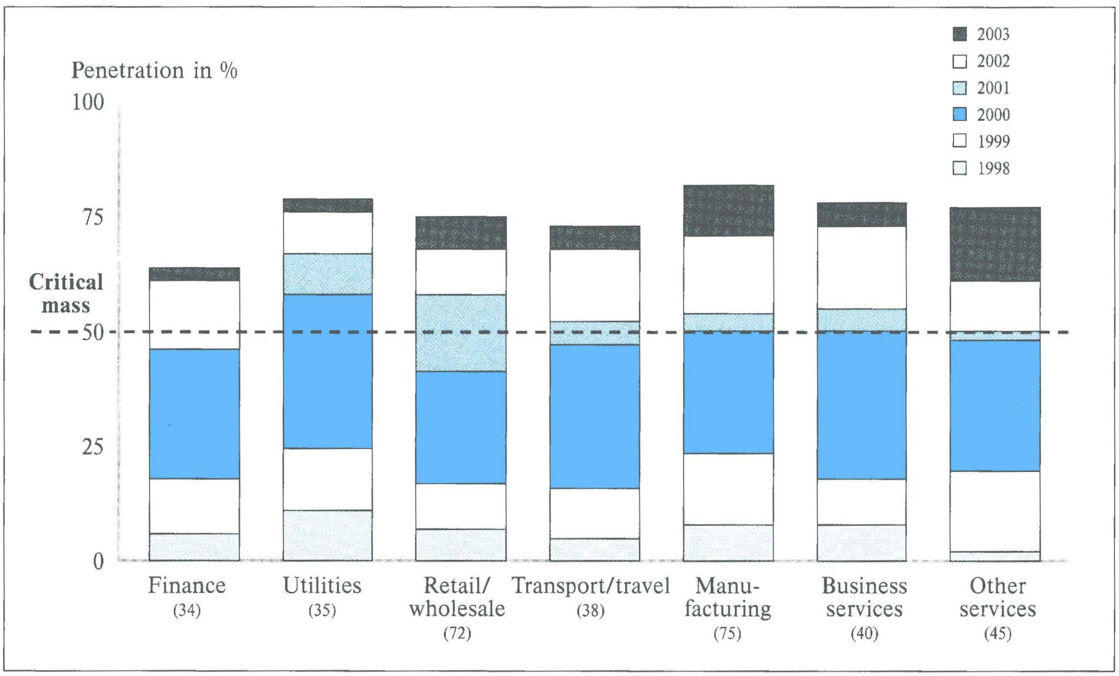
Base: E-commerce users/ planned users

Figure 37
Critical mass for sales applications (by country)



Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown
Base: E-commerce users/ planned users

Figure 38
Critical mass for sales applications (by sector)



Note: Figures in brackets show number of respondents
Base: E-commerce users/ planned users

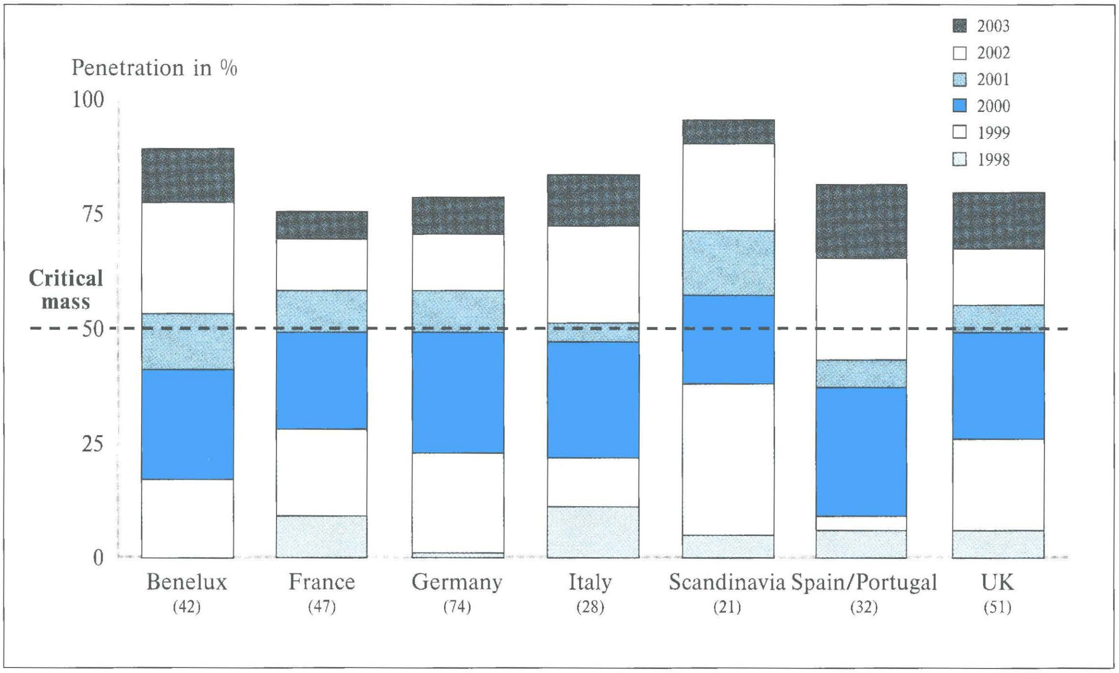


Figure 39
Critical mass for post-sales applications (by country)

Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown
Base: E-commerce users/planned users

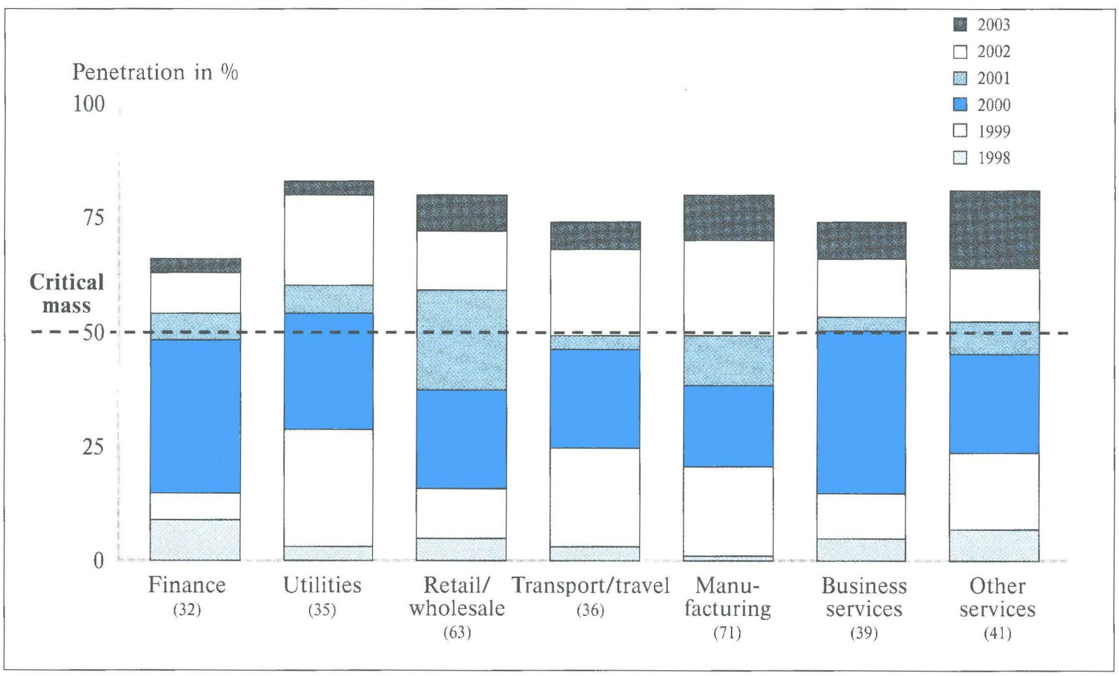
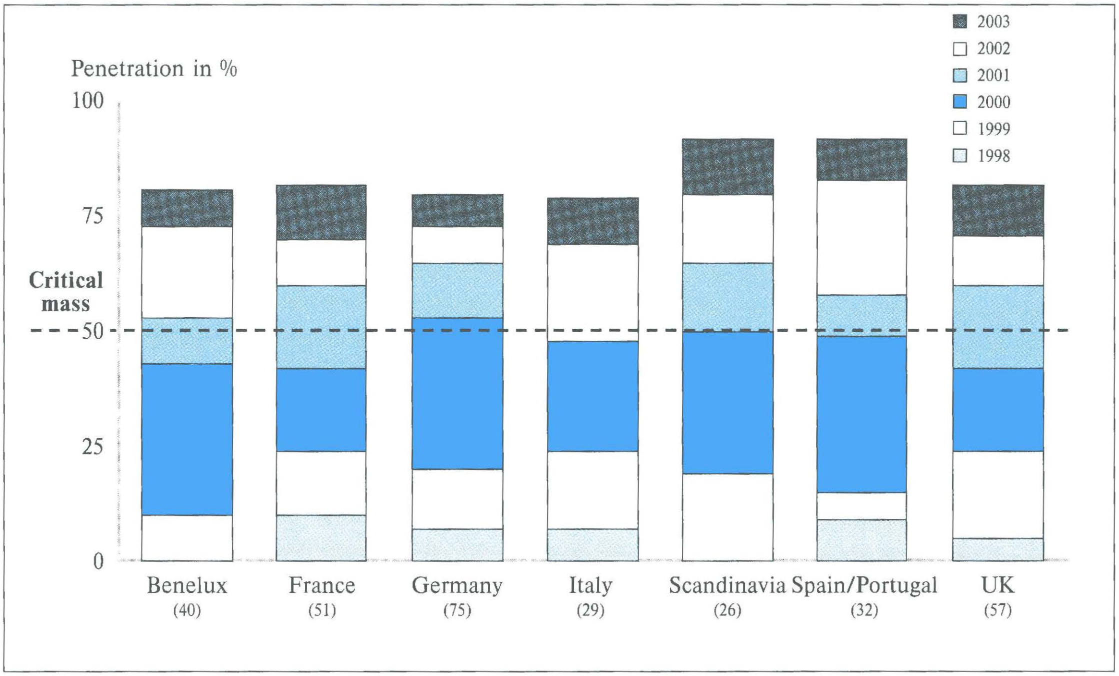


Figure 40
Critical mass for post-sales applications (by sector)

Note: Figures in brackets show number of respondents
Base: E-commerce users/planned users

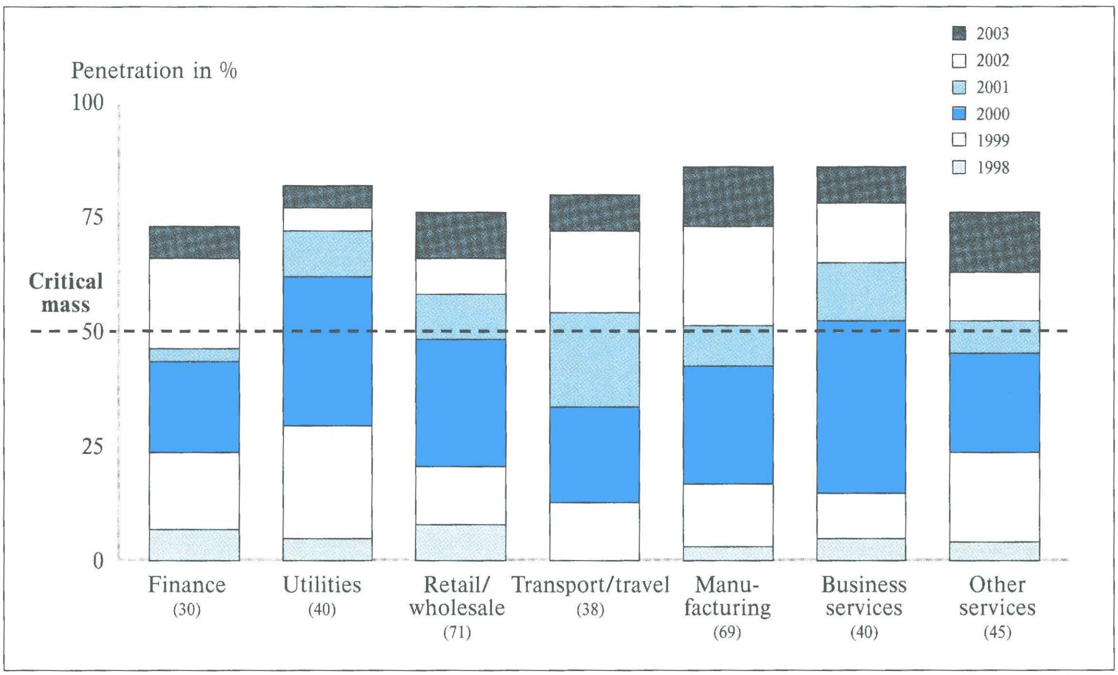
Figure 41
Critical mass for purchasing applications (by country)



Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown

Base: E-commerce users/ planned users

Figure 42
Critical mass for purchasing applications (by sector)



Note: Figures in brackets show number of respondents

Base: E-commerce users/ planned users

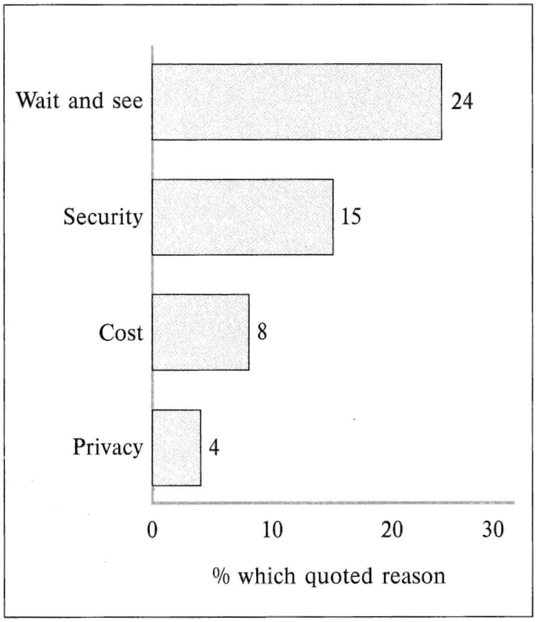


Figure 43
Main reasons for having no intention to adopt E-commerce

Note: Selected reasons only shown

Base: Organisations with no current plans to adopt E-commerce (112 respondents)

The surprisingly low levels of responses to these barriers suggests that this group as a whole is unaware of E-commerce and the issues it raises. The fact that the majority of businesses who cited security and privacy as issues came from the advanced E-commerce country markets, Germany, Scandinavia and the UK, supports this view. All the Spanish businesses in the group with no plans to implement E-commerce cited "wait and see" as a reason for not adopting E-commerce, plus more than half of the Italian businesses; Spanish businesses were also most concerned about cost.

The finance, utilities and transport/travel sectors were most concerned with security, and organisations citing privacy as a barrier were all in the other services sector. Retail, manufacturing and utilities lead in taking a "wait and see" approach.

5.2.1. Security issues

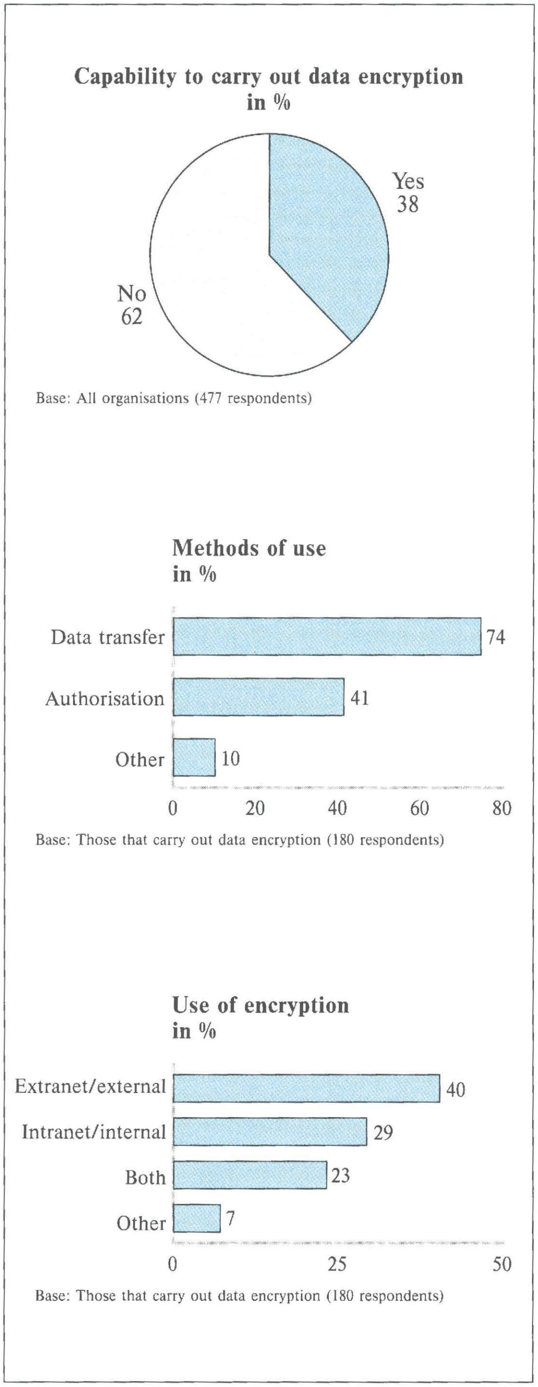
The relatively low penetration of a security technology fundamental to E-commerce, data encryption, indicates that many E-commerce applications function at a very low level of security *(Figure 44)*. This is potentially a severe threat to E-commerce as the market grows and malicious damage, fraud and data theft become more widespread.

Other surveys (see section 2.4.4.), confirm that security is still seen as a major barrier to E-commerce, and to marketing applications as much as to transactional applications such as sales and post-sales. It is clear from the Romtec survey that the latter application categories are trailing marketing applications, and as their higher security requirements affect their cost, this constitutes a further barrier to the implementation of transaction-based E-commerce applications over the Internet.

5.2.2. Other constraints

A very high proportion of businesses gave "other" reasons for not adopting E-commerce. The most frequently cited reasons in this category included: a perception that the organisation is very small and therefore E-commerce is irrelevant to them; no customer need – customers are happy with the existing way of doing business with the organisation; E-commerce is not applicable to their line of business (e.g. car parking, cleaning business); the organisation lacks an internal IT capability; the organisation feels its culture is too conservative to adapt to E-commerce; businesses are in a subsidiary and do not know the IT plans of the parent organisation; the organisation conducts telephone-based business and does not believe E-commerce will add value to this. Reasons with one or two responses included: speed of response possible over the Internet; too busy with the millennium problem; lack of knowledge about E-commerce; and legal restrictions on transfer of documents.

Figure 44
Penetration and use of encryption technology



6. Key trends for the future

This section considers E-commerce trends indicated from the chapter research in six areas:

- country trends;
- sectoral trends;
- application trends;
- business model change trends;
- technology trends;
- regulatory trends.

6.1. Country trends

The Mediterranean countries, Spain/Portugal and Italy, will continue in catch-up mode with Northern Europe and their aggressive investment in, and exploitation of, E-commerce will bring them up to comparable levels of capability by 2002. France is also in catch-up mode, but is currently showing less enthusiasm for E-commerce than its southern neighbours. The rate of development in the more advanced Northern European markets will begin to slow after 2000, with the UK already showing signs of dropping back behind Germany and Scandinavia.

6.2. Sectoral trends

Finance appears one of the most conservative sectors in its approach to E-commerce: however, it also emerges as the only sector taking a strategic view. The implementation of a strategic approach to E-commerce will inevitably mean business model change, a longer process than merely bolting support for the Internet onto the existing business (see section 6.4.).

Utilities are the most demanding of a strong financial business case for investment in E-commerce. However, they are also being driven into early adoption by the threat of competition in increasingly deregulated markets. E-commerce within this sector will reach critical mass early in the new millennium.

The transport/travel sector, although showing clear signs of how the Internet and disintermediation are increasing competition, is not rushing to put Internet E-commerce applications in place to counter this threat. In fact, transport/travel will be one of the later sectors to achieve critical mass in marketing, sales, purchasing and post-sales applications. This may reflect the effect of existing private electronic infrastructure which is locking transport/ travel companies into a specific business model from which it will be difficult to break free until the volume of Internet transactions and sales rises.

Many government organisations are planning to lead best practice in the E-commerce arena by carrying out more of their informational, transactional and procurement services online, and many services will be rolling out by the end of 1999. Such a public sector lead will considerably advantage the commercial sectors within these countries.

6.3. Application trends

In the year 2001, critical mass point will be reached for E-commerce marketing applications in Europe, when the 1998 ratio of web-marketeers to non-web-marketeers will be reversed.

The trend towards putting customer-focussed E-commerce applications in place first will continue, with only the most advanced organisations installing Internet-based supply chain applications that support interaction with suppliers before 2002. By 2001, however, critical mass point will be reached for E-commerce purchasing and sales applications, supporting growing numbers of supply chains end-to-end.

"Killer" applications will be those that promote transparency between buyer and seller, making it easy and attractive for customers to do business with a particular company. By 2001, critical mass point will be reached for E-commerce post-sales applications. These will begin to be customers' first choice when seeking support, pushing the telephone into second place.

The trend towards more ad-hoc relationships with customers will continue. This has implications for the selling organisation's competitiveness and cost structures, and also for the quality of its marketing and sales applications. However, transparency and support for a high percentage of ad-hoc transactions require innovation and business change. Most organisations will not be ready to face the upheaval required to make such changes until after the millennium (see section 6.4.).

6.4. Business model change trends

As we have seen in section 4., the top five benefits of E-commerce identified by the survey sample overall, are:

- improved Quality of Service to customers;
- new channel to market;
- flexibility of customer service;
- competitive advantage;
- new markets/customers.

The first three of these, the most highly-rated benefits, are being partially achieved without organisations significantly changing their business models at present. All three benefits are derived from extending service to existing customers through a new channel and, in 1998, very small portions of the customer base were involved. Ernst & Young's retention example quoted in section 2.3. - customer retention being the unspoken assumption behind these benefits - suggests that 6% of customers may be retained as a result of a financial organisation providing online services. This may have a significant impact on an organisation's profitability: Bain & Co has found that a 5% increase in retention can increase profitability between 25% and 85%; while PricewaterhouseCoopers shows that a 2% increase in customer retention has the same profit impact as a 10% reduction in overhead costs.

However, the small volumes of customers and revenues are not yet encouraging wholesale changes to the way an organisation traditionally does business. The penetration profile of E-commerce applications and technology suggests that customers are being offered limited marketing, sales and post-sales capabilities across the Internet at the moment rather than fully transparent services - the ability to self-serve, check accounts, receive personalised offers and make adjustments to requirements. As the latter are implemented, organisations will need to make more profound changes to their business model and processes. By the year 2000, growing numbers of E-commerce pilots will begin to put pressure on organisations to do so.

To achieve the benefits of competitive advantage and access to new markets/customers, organisations do need to change existing business processes and support structures more radically. In sectors such as retail/wholesale, transport/travel and other services, which rank competitive advantage highly, there are emerging examples of innovative exploitation of the Internet, including highly targeted cybermalls such as Buckingham Gate, and marketplaces (EMB), and the creation of Internet-based value-added service offerings (Scandinavian travel company in section 2.3.). Organisations competing in these areas often create new Internet companies with different business models to handle this area of the business, however, rather than attempting the more difficult task of re-engineering their existing business to integrate the Internet channel.

It is likely that the majority of companies will be using the Internet to trade with their partners, and particularly their customers, by 2002. By 2005, most supply chains will trade electronically. Leading-edge organisations by this time will have re-engineered themselves as virtual companies, keeping control of brand and marketing functions and using electronic networks to procure the support services they need, monitor service level agreements with provider organisations, manage distributed processes across provider organisations and enter into new partnerships for marketing and support purposes.

6.5. Infrastructure and technology investment trends

The basic infrastructure for E-commerce - modem and Internet-enabled devices of all types, public infrastructure and private networking technology - will continue to expand rapidly. The roll-out of Web-enabled mobile phones, digital broadcasting services and smart card-enabled PCs in 1999 will increase the choice of electronic ways in which businesses can interact with their customers. A number of services providers, including retailers and banks, will also provide basic access to the Internet, increasing the numbers of potential customers online.

A significant number of European organisations, particularly those with plans for E-commerce and those in large companies, will exploit this infrastructure in defensive mode. They will adopt Internet E-commerce because their competitors do, rather than because they have a clear strategy and business case. In these circumstances, their investment in E-commerce technology and applications may be limited and potentially ineffective within two to three years. Those organisations investing in technology that changes external relationships with and processes between business partners and customers are likely to be more successful in the long-term. However, their short-term position may be precarious due to the lack of critical mass in E-commerce activity before 2000. Such companies are already showing themselves as E-commerce pioneers and are likely to be small to medium-sized, with an entrepreneurial, expansion-oriented culture.

By 2002, it is possible that the public network infrastructure will begin to fail to keep up with the increasing demands of Internet users and delays will become unacceptable. New multichannel services provided by digital broadcasting will replace the Internet as the focus for business-to-consumer E-commerce, while an increasing proportion of business-to-business E-commerce will be conducted over private IP-based Extranets. By 2005, smart cards will become key to all aspects of E-commerce.

6.6. Regulatory trends

By 2000, consumer protection regulation should be clarified and contract law and domain names/trademarks issues resolved through agreement on practical guidelines. A new Internet global taxation regime will begin to emerge after 2002, while favourable national legislation will fuel the growth of secure "trust" infrastructure (certification, digital signatures) for E-commerce. By 2005, a workable framework for a global trust infrastructure will be laid down, as a result of international harmonisation of laws governing the licensing of certification authorities and data protection.

Annex

A 1. Survey methodology

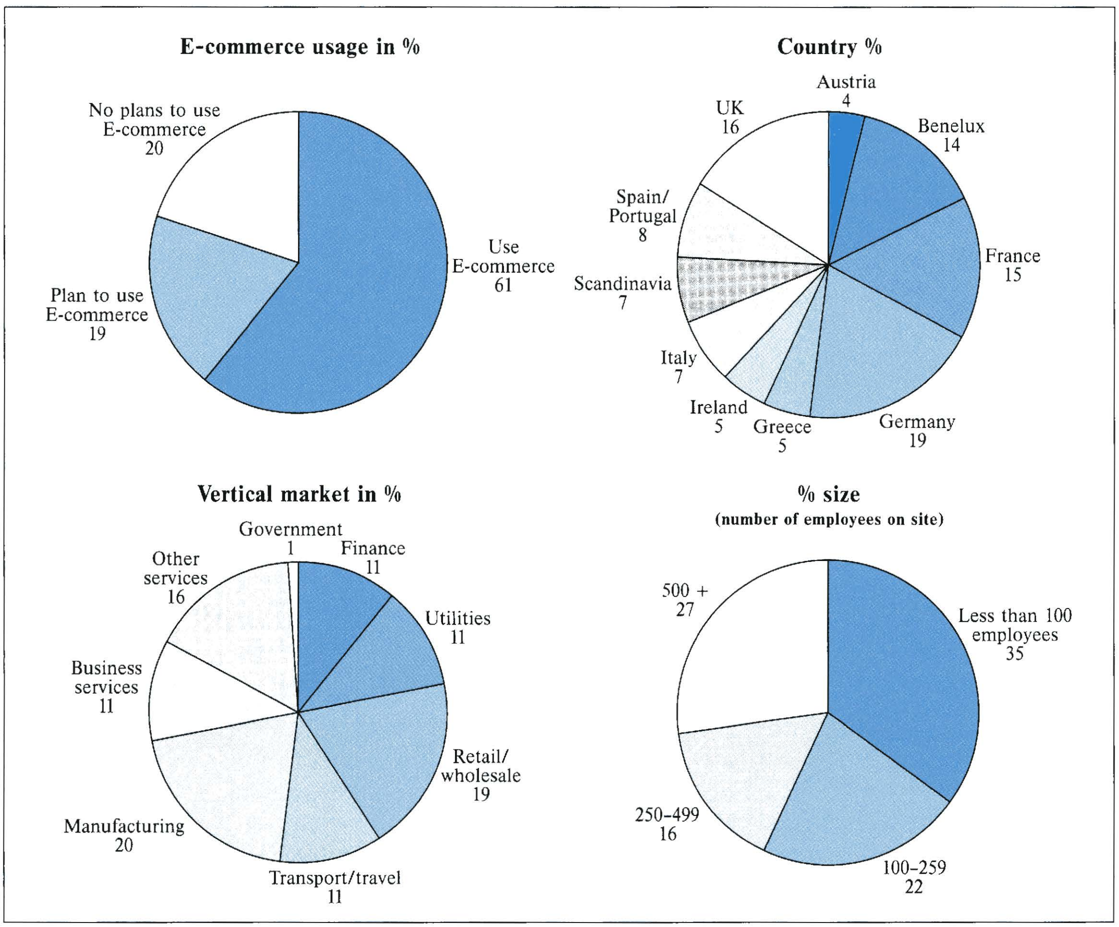
A 1.1. Overview

In September 1998, Romtec contacted 3,241 organisations to ask them about their use of E-commerce. 570 companies, across the EU and Norway and eight industry sectors (see section A 1.5.), provided responses to the survey. The questionnaire used for the survey appears at the end of this Annex.

The objectives of the survey were to:

- evaluate the current penetration of E-commerce across countries and sectors;
- confirm the order in which E-commerce applications are put in place;
- determine the likely growth of E-commerce applications towards critical mass;
- define the drivers and barriers to E-commerce adoption, including the financial triggers that lead to adoption.

Figure A 1
Sample breakdown



Note 1: For this survey Scandinavia includes Denmark, Norway and Sweden only
Note 2: See sections A 1.4. and A 1.5. for notes regarding analysis by country and vertical market
Base: 570

A 1.2. Quotas set

Quotas were set in order to achieve a certain number of interviews by country, industry sector, site size (number of employees on site) and, perhaps most importantly, by type of E-commerce usage (i.e. current user, planned user, those with no plans).

E-commerce usage quotas

As the majority of the questions within the questionnaire focused upon current and planned E-commerce using organisations, Romtec aimed for 60% of the sample to be current E-commerce users and 20% to be planned users of E-commerce. *Figure A1* shows that Romtec matched these quotas very closely, with 61% of the total sample being current E-commerce users and 19% being planned users.

A 1.3. The effect of quotas on the findings of the report

Findings relating to current/planned E-commerce users/those with no plans:

The majority of the findings within this survey are based on analysing current and planned E-commerce using organisations, or analysing organisations with no plans for E-commerce. These findings were not affected by the quotas set on E-commerce usage and can be regarded as being the results of a random survey.

Findings relating to all European organisations:

To counteract any bias that the E-commerce usage quotas would have on the total sample, Romtec has analysed the findings that relate to all European organisations based upon a total sample size of 416 organisations. This was the amount of interviews conducted before Romtec had to begin biasing the sample towards achieving certain types of quota. Therefore, the Romtec findings for all organisations (e.g. Internet-based E-commerce penetration) can also be regarded as being the results of a random survey.

A 1.4. Countries interviewed

Figure A1 shows the different countries which were interviewed. No individual analysis has been made of the findings relating to Austria, Eire and Greece due to the low number of interviews conducted in each of these countries. However, the findings relating to these countries are contained within the figures pertaining to all European businesses and the figures by sector.

Note that for this survey Scandinavia includes Denmark, Sweden and Norway only (and does not include Finland).

A 1.5. Industry sector definitions

Businesses across eight sectors were interviewed for the survey. The following groups of NACE codes were used to define industry sector boundaries:

	NACE groups
Finance	65-67
Utilities	64, 40, 41
Retail/wholesale	50-52
Transport/travel	62, 63, 64, 12
Discrete manufacturing	28-36
Business services	70-73
Other services	74
Government	75

Whilst the findings relating to government are contained within the figures pertaining to all European businesses and the figures by country, because of the low number of government sector interviews conducted, no individual analysis has been made of this sector.

A 1.6. Currency figures used in report

All currency figures in this report are quoted in ECU, using the exchange rate as of 4th December 1998.

A 1.7. Margin of error

The margin of error is a reflection of how accurate the survey findings are in relation to the true population. For example, if the survey shows that 47% of businesses use E-commerce and the associated margin of error is +/- 5%, then we are 95% confident that the true population percentage lies between 42% and 52%.

Because the base for many of the questions in the survey differed depending upon the routing of the questionnaire, it is not practical to provide the relevant margin of error relating to every figure in the survey. However, the following examples provide the reader with a guideline:

- The margin of error for the sample of **458** E-commerce users/planned users (e.g. *Figure 12*) is **+/- 4.6%**
- The margin of error for the sample of **112** businesses with no current plans to adopt E-commerce (e.g. *Figure 43*) is **+/- 9.3%**
- The margin of error relating to the total random survey sample (see section A1.3) of **416** businesses (e.g. *Figure 1*) is **+/- 4.8%**
- The margin of error for the sample of **51** French E-commerce users/planned users (e.g. *Figure 41*) is **+/- 13.7%**
- The margin of error for the sample of **45** other services E-commerce users/planned users (e.g. *Figure 42*) is **+/- 14.6%**

Note: All margins of error quoted above are calculated at the 95% level of confidence.

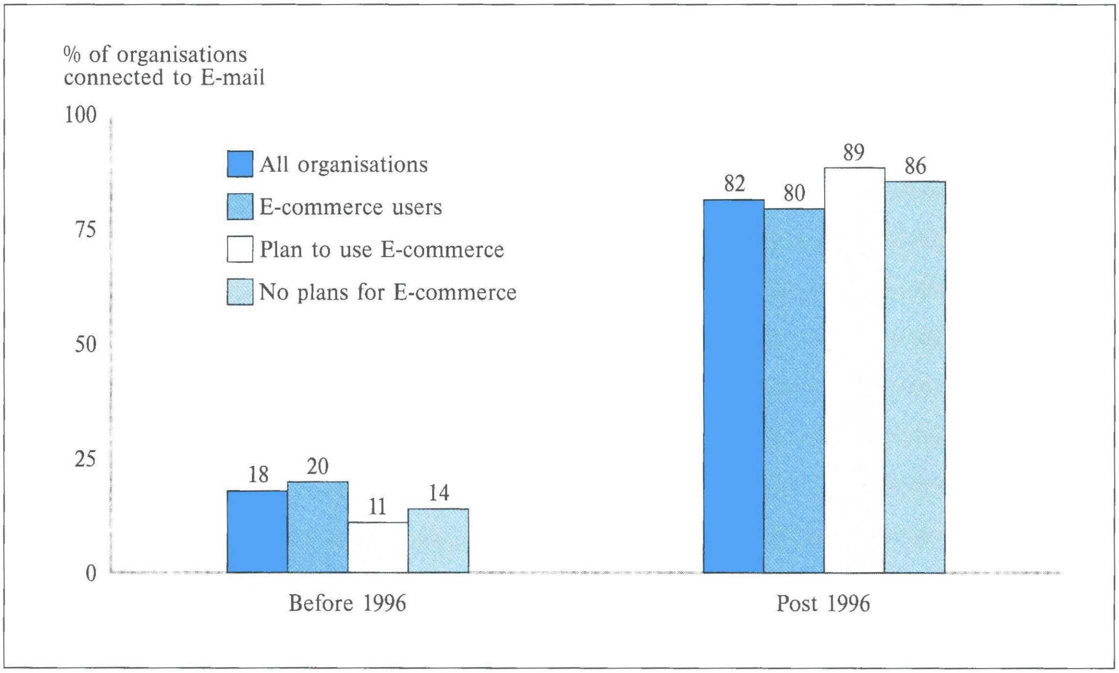


Figure A 2
Period of connection to E-mail

Base: E-mail users (453 respondents)

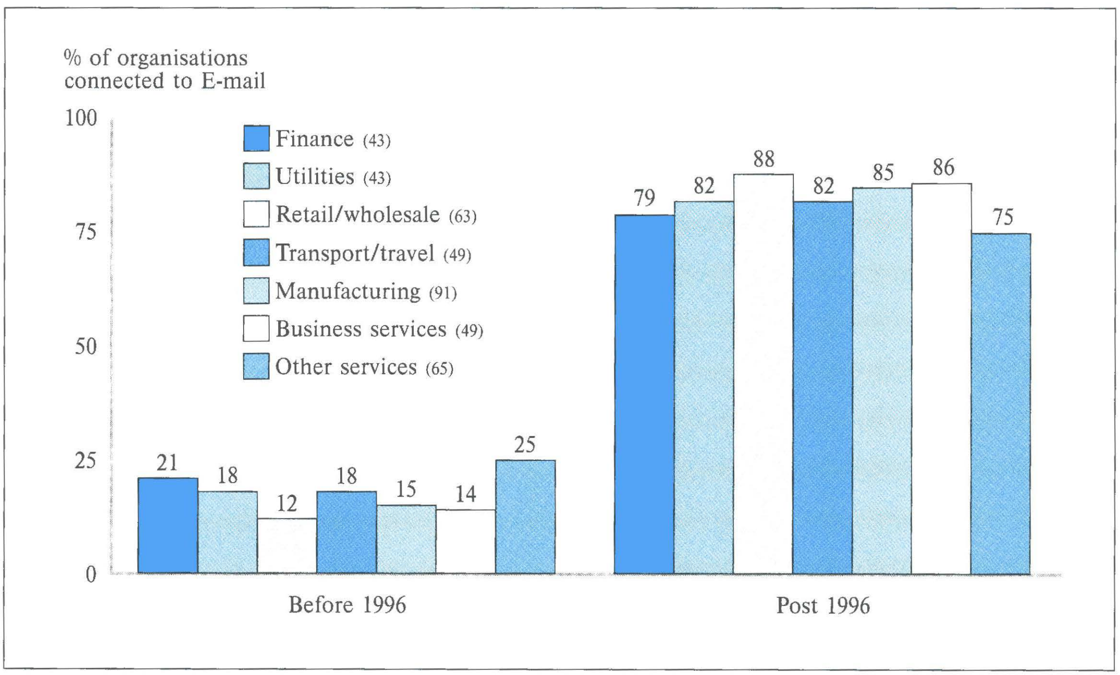
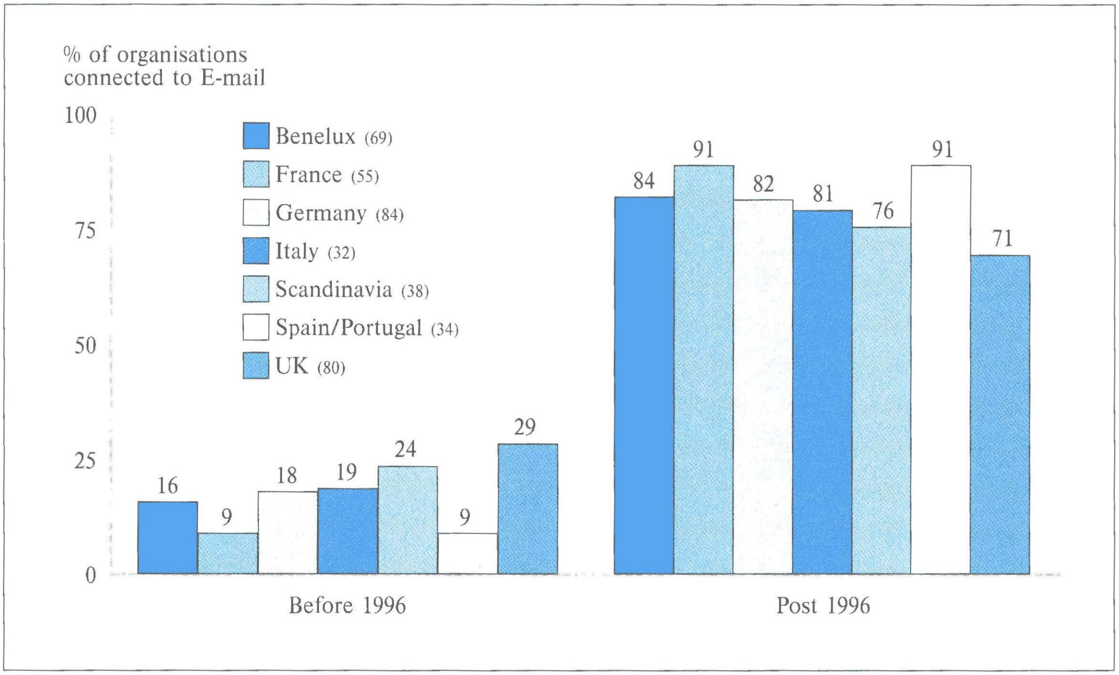


Figure A 3
Period of connection to E-mail (by sector)

Note: Figures in brackets on keys show number of respondents

Base: E-mail users

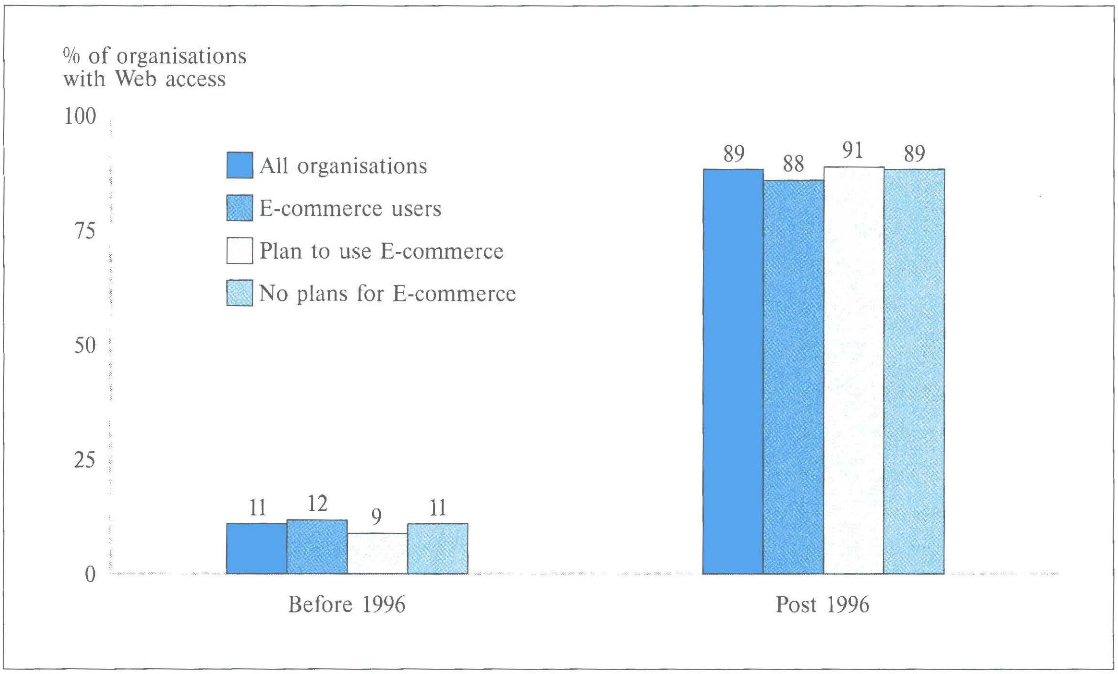
Figure A 4
Period of connection to E-mail (by country)



Note: Figures in brackets on keys show number of respondents

Base: E-mail users

Figure A 5
Period of connection for Web access



Base: Organisations with Web access (393 respondents)

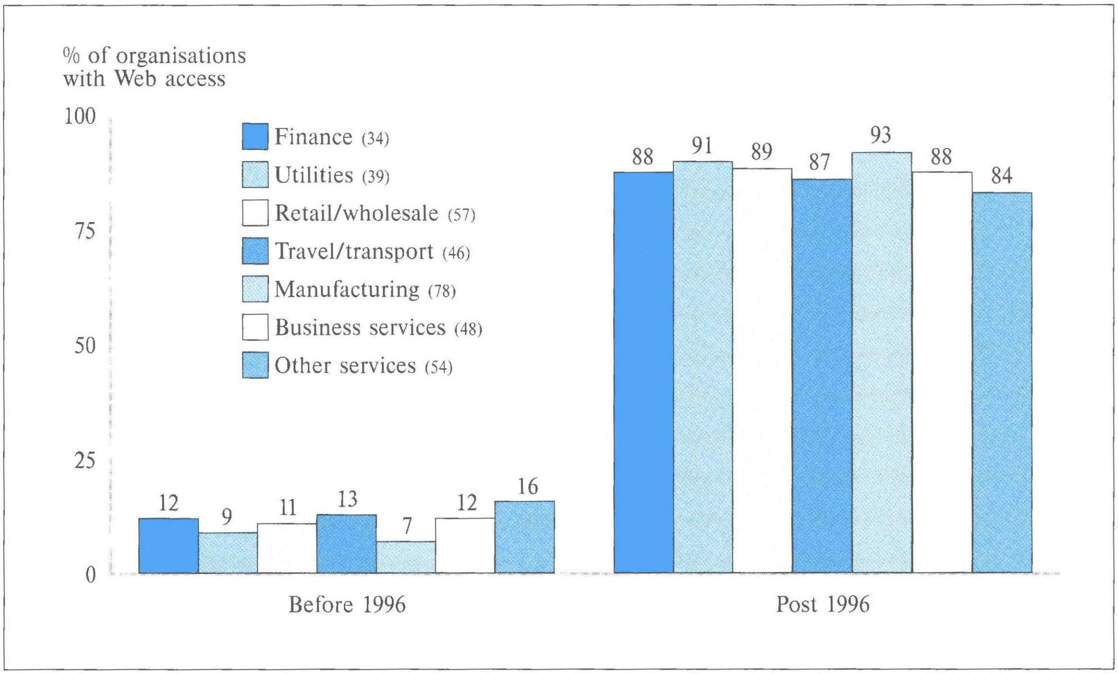


Figure A 6
Period of connection for Web access (by sector)

Note: Figures in brackets on keys show number of respondents

Base: Organisations with Web access (393 respondents)

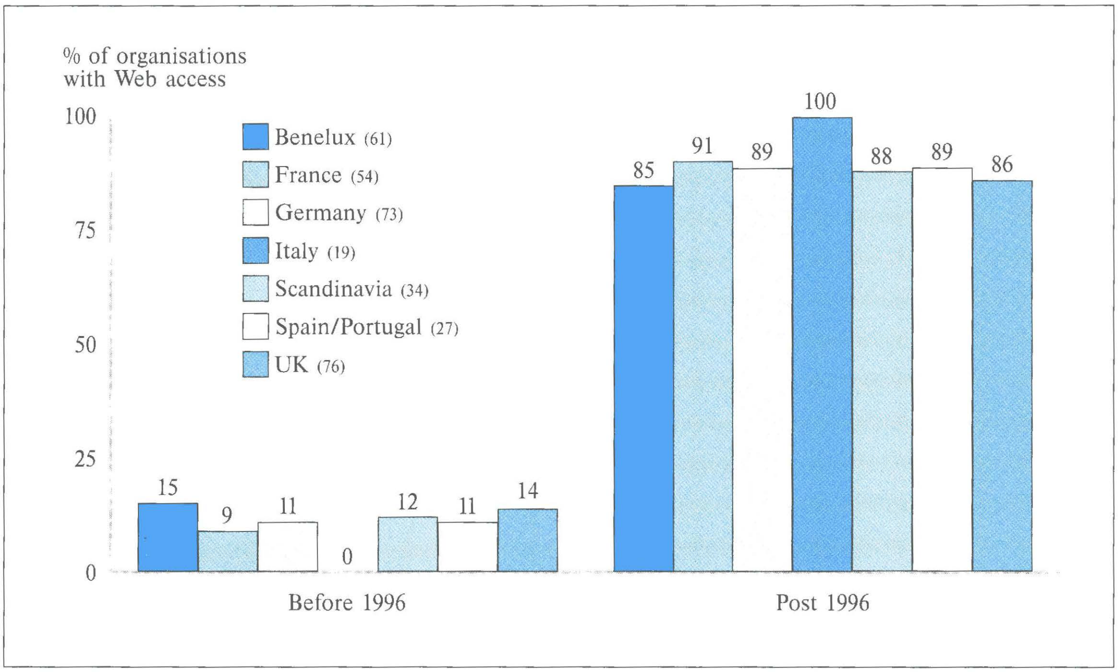
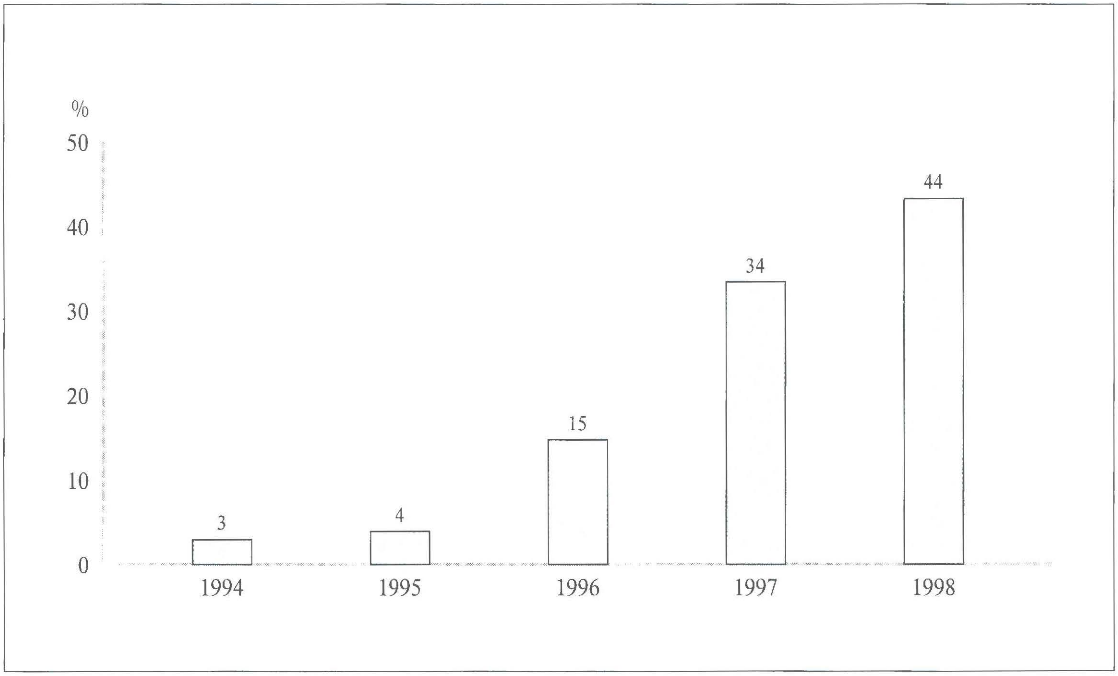


Figure A 7
Period of connection for Web access (by country)

Note: Figures in brackets on keys show number of respondents

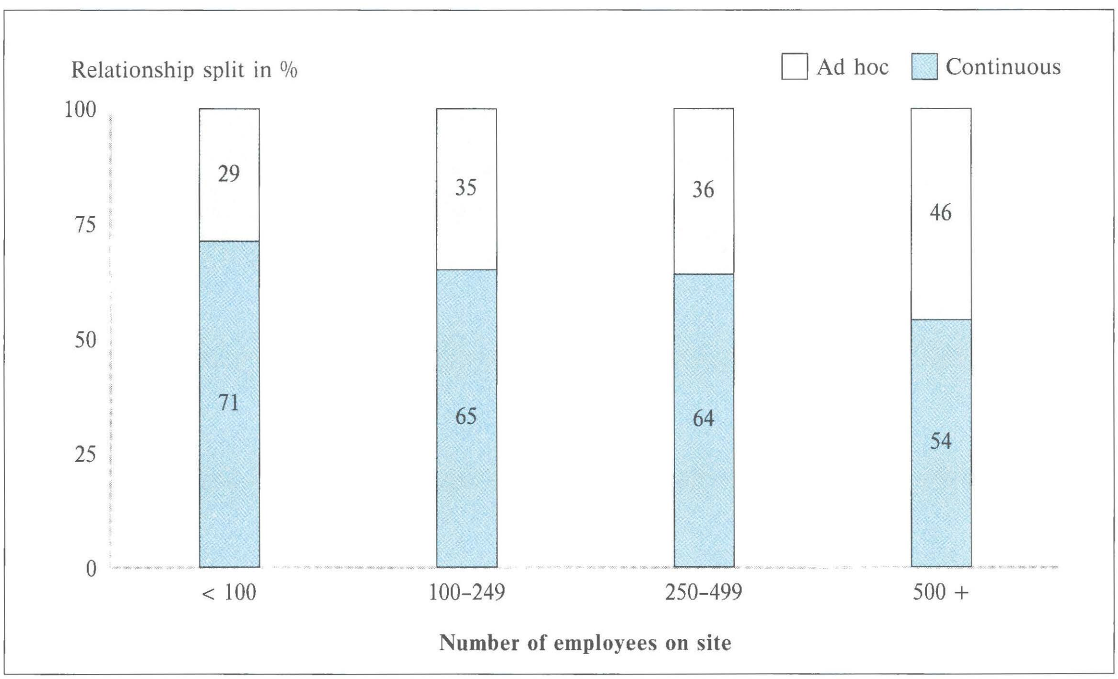
Base: Organisations with Web access (393 respondents)

Figure A 8
Year in which organisations began to use Internet-based E-commerce



Base: Internet-based E-commerce users (137 respondents)

Figure A 9
Relationship between businesses with E-commerce and their customers (by size)



Base: E-commerce users who have E-commerce applications in the area of marketing/selling to customers (227 respondents)

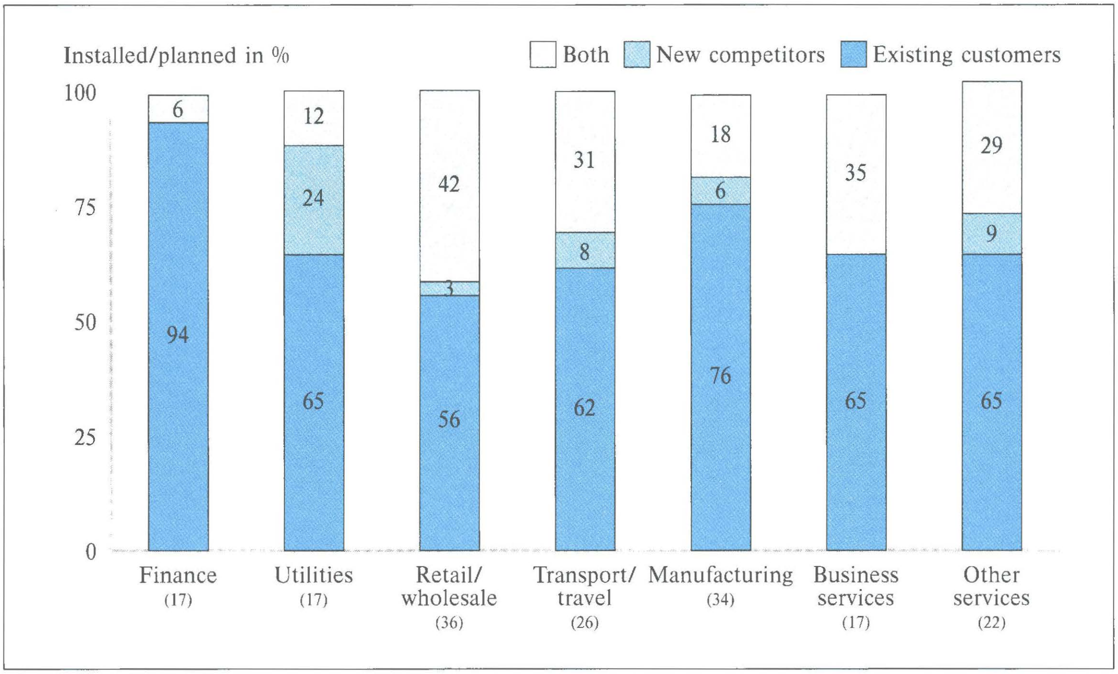


Figure A 10
Breakdown of competitors influencing adoption of E-commerce (by sector)

Note: Figures in brackets show number of respondents

Base: E-mail users/ planned users

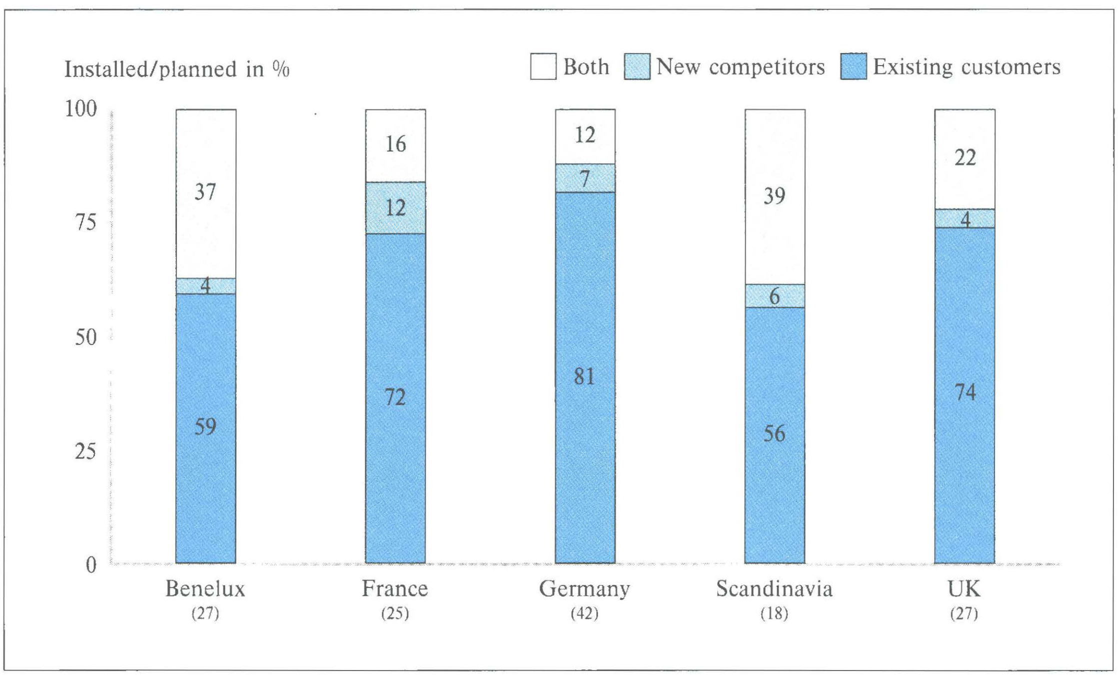
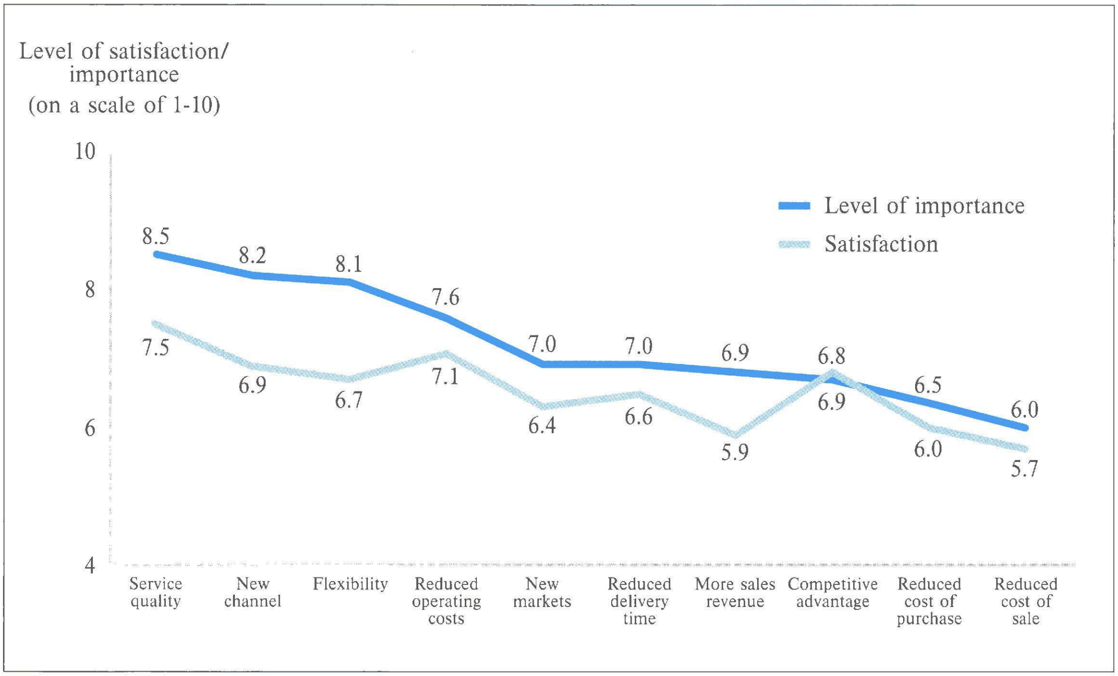


Figure A 11
Breakdown of competitors influencing adoption of E-commerce (by country)

Note 1: Figures in brackets show number of respondents
Note 2: Selected countries only shown

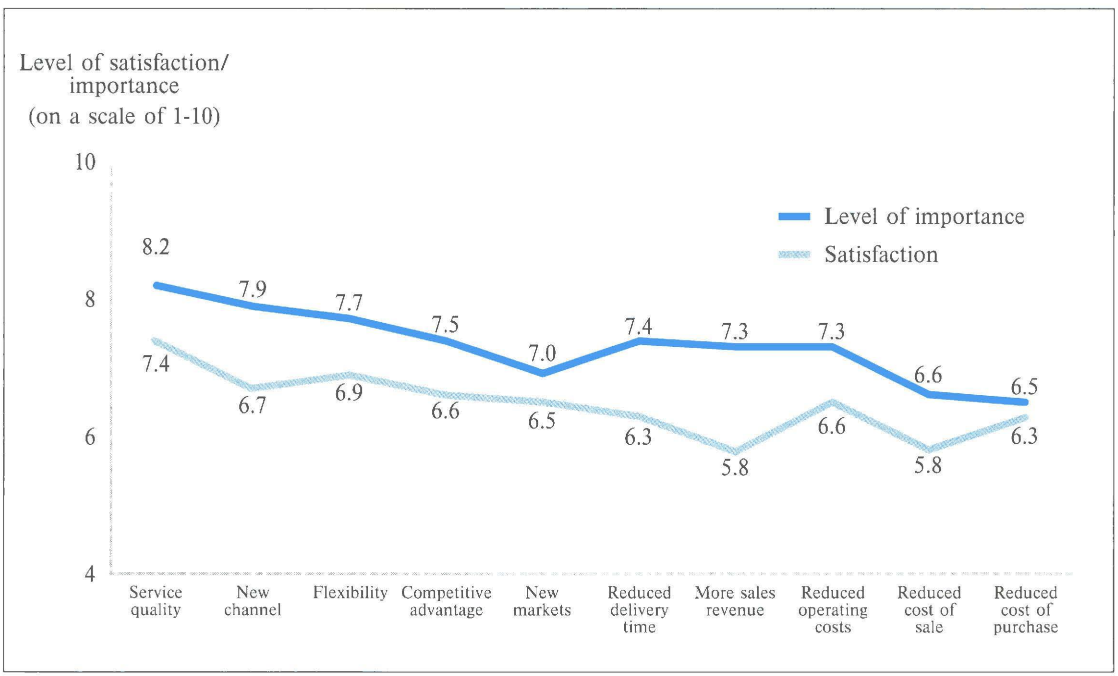
Base: E-mail users/ planned users

Figure A 12
Satisfaction and importance associated with benefits of E-commerce (in the utilities sector)



Base: E-commerce users/ planned users in the utilities sector (26–45 respondents)

Figure A 13
Satisfaction and importance associated with benefits of E-commerce (in the retail/wholesale sector)



Base: E-commerce users/ planned users in the retail/wholesale sector (51–83 respondents)

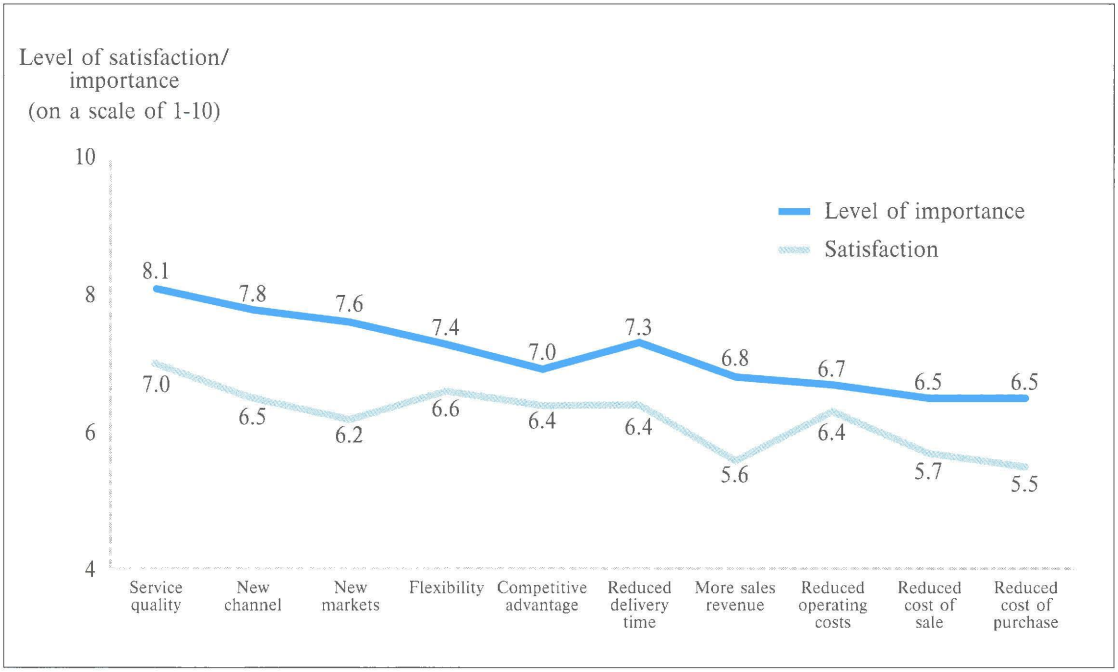


Figure A 14
Satisfaction and importance associated with benefits of E-commerce (in the manufacturing sector)

Base: E-commerce users/ planned users in the manufacturing sector (47–83 respondents)

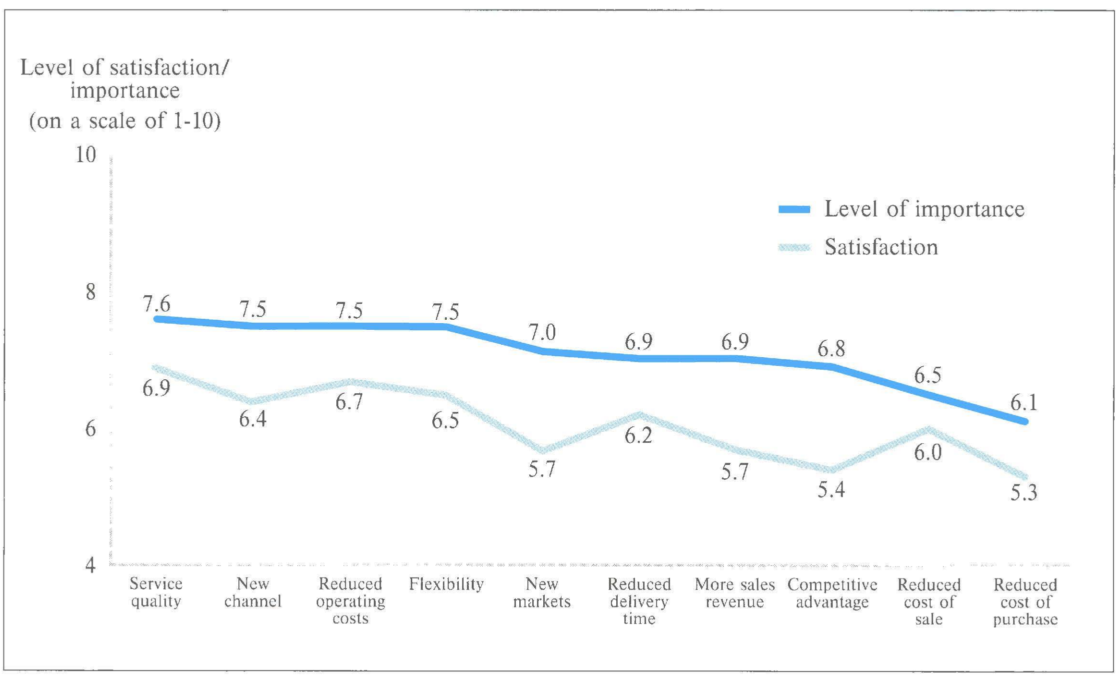
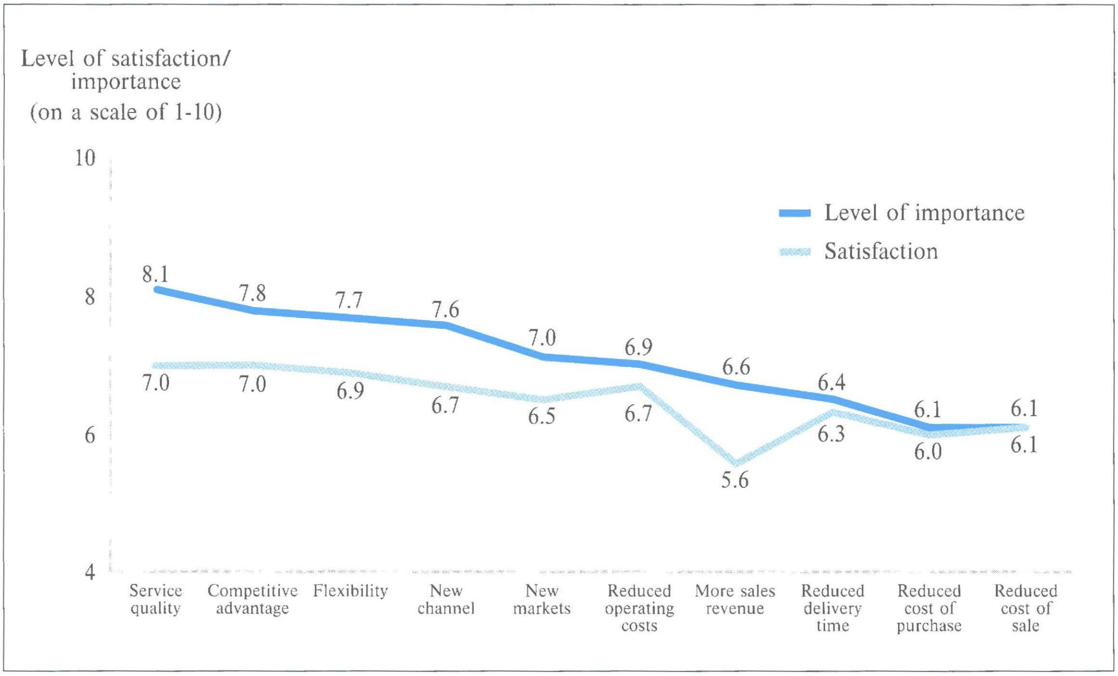


Figure A 15
Satisfaction and importance associated with benefits of E-commerce (in the business services sector)

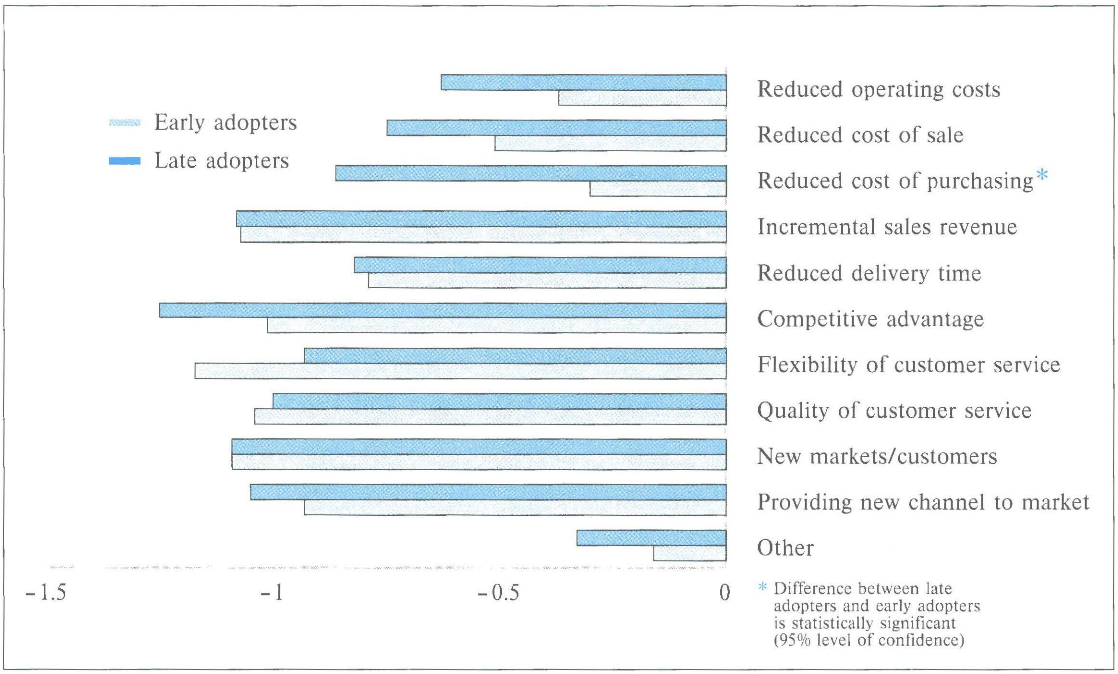
Base: E-commerce users/ planned users in the business services sector (25–43 respondents)

Figure A 16
Satisfaction and importance associated with benefits of E-commerce (in other services sector)



Base: E-commerce users/ planned users in other services sector (31-57 respondents)

Figure A 17
Mean gap analysis on benefits of implementing E-commerce



Note: Reduced cost of purchasing produced a significant gap between early and late adopters. This implies that early adopters placed more importance on this factor than late adopters.

European E-commerce survey

Introduction

Good morning/afternoon Mr/Ms _______ We are conducting a survey for the European Commission about "E-commerce". Perhaps I should explain that our definition of E-commerce is **commercial activity conducted over electronic networks, often over the Internet, which lead to the purchase or sale of goods or services.** We would like to talk to someone in your organisation who has a **commercial** (as opposed to technical) understanding of E-commerce.

Perhaps I could just mention the benefit of participating. E-commerce is becoming a tool for gaining competitive advantage and we will be posting the results of this survey on our web site. You will be able to compare your own position with comparable organisations by size, sector and country in Europe.

Would you be the best person to talk to?

1. Generic applications

1.1 Is your organisation connected to the **Internet** for E-mail or Web access? Y / N

If Y, in which year was this connection installed? *(year)* [| | |]

If Y, is it connected by a server on-site or is it hosted elsewhere?

Server [ ]
Host [ ]

1.2 (If Y to 1.1) Do you have an **Intranet**? Y / N

If Y, in which year was this installed? [| | |]

1.3 (If Y to 1.2) Is your Intranet connected to another Intranet (or other Intranets), i.e. have you implemented an **Extranet**? Y / N

If Y, in which year was this connection implemented? [| | |]

1.4 Do you use any of the foregoing Internet-based systems to conduct business transactions with customers or suppliers (i.e. **E-commerce**)? Y / N

If Y, in which year did you start? [| | |]

If N, when do you plan to? [ ]

1.5 Are you able to communicate with other locations using **videoconferencing**? Y / N

If Y, in which year was this installed? [| | |]

1.6 Other than Internet communication methods: Do you use any other form of data communication (e.g. EDI) for transactions with customers or suppliers? Y / N

If Y, in which year was this installed? [| | |]
No plan

Do you plan to change to an Internet-based system? [| | |]
D / K

2. E-commerce status

2.1 May I confirm with you that you:

(If Y to 1.4) Are an E-commerce user?	*(Y = category A)*	Y / N
(If N to 1.4 but have a plan date) Plan to be an E-commerce user?	*(Y = category B)*	Y / N
(If none of the above) Have no current intention to be an E-commerce user?	*(Y = category C and proceed to section 5)*	Y / N

3. E-commerce applications (categories A and B)

I would now like to ask you about the scope of your installed/planned E-commerce applications. Firstly, are these applications in the functional area of:

Marketing/selling to customers Y / N
Purchasing from suppliers Y / N

3.1 Marketing/selling
Which of the following applications are included and when were they installed or when do you plan to install?

3.1.1 Marketing (e.g. Web site for advertising, promotion, etc.) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.2 Sales (e.g. receiving orders from customers) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.3 On-line supply to customers (e.g. electronic delivery or confirming non-electronic delivery details) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.4 Customer support (e.g. answering commercial or technical queries, providing updates or news etc.) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.5 Customer monitoring and relationship development (e.g. needs and satisfaction research, consultation, etc.) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.6 Recruitment of marketing/sales staff Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.7 Customer invoicing, collection or payment Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.8 Other applications: Y / N

Application ______________________________

Installed ☐☐☐☐ Planned ☐☐☐☐

Application ______________________________

Installed ☐☐☐☐ Planned ☐☐☐☐

3.1.9 Is your E-commerce relationship with customers:

a) continuous ☐ b) ad hoc ☐

3.1.10 Since your customers feature in many of these E-commerce applications, could you give an overall turnover split between business and consumer **end customers** (i.e. not intermediaries): Y / N

Business ☐☐☐ Consumer ☐☐☐

3.1.11 Is the proportion of sales through E-commerce significant in relation to total sales? Y / N

If Y, what percentage of the total for sales ☐

3.2 Purchasing

Which of the following applications are included and when were they installed or when do you plan to install?

3.2.1 Accessing/surfing Web sites of possible suppliers to make purchasing decisions Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.2 Purchasing commitments (e.g. sending orders to suppliers) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.3 Receiving purchases electronically or receiving confirmation of delivery details Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.4 Receiving after-sales support from supplier (e.g. answers to commercial or technical queries, progress reports, etc.) Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.5 Receiving and responding to supplier requests for information and opinions from you as a customer Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.6 Recruitment of non-marketing/sales staff Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.7 Payment of suppliers Y / N

Installed ☐☐☐☐ Planned ☐☐☐☐

3.2.8 Other applications: Y / N

Application ______________________

Installed [ ][ ][ ][ ] Planned [ ][ ][ ][ ]

Application ______________________

Installed [ ][ ][ ][ ] Planned [ ][ ][ ][ ]

3.2.9 Is your E-commerce relationship with suppliers:

a) continuous [ ] b) ad hoc [ ]

3.2.10 Is the proportion of purchasing through E-commerce significant in relation to total purchasing? Y / N

If Y, what percentage of the total for purchasing [ ]

4. Motivations (categories A and B)

4.1 What caused you to decide to adopt E-commerce?

A) Targeting new markets/customers ______________________

B) Competition ______________________

C) Better (support) for customers/suppliers ______________________

D) Other, please specify ______________________

4.2 How important on a scale of 1-10 (1 least - 10 most) are each of the following benefits and how do you rate the **satisfaction** or **expectation** in each case?

	IMP	**SAT/EXP**
reduced operating costs	[ ]	[ ]
reduced cost of sale	[ ]	[ ]
reduced cost of purchasing	[ ]	[ ]
incremental sales revenue	[ ]	[ ]
reduced delivery time	[ ]	[ ]
new markets/customers	[ ]	[ ]
providing new channel to market	[ ]	[ ]
competitive advantage	[ ]	[ ]
flexibility of customer service	[ ]	[ ]
quality of customer service	[ ]	[ ]
other ______________	[ ]	[ ]

4.3 Presumably, E-commerce must also be justified in financial terms, i.e.

4.3.1 By what percentage would you need to **reduce operating costs** to make E-commerce financially attractive? [ ]

4.3.2 by what percentage would you need to **reduce cost of sale** to make E-commerce financially attractive? [ ]

4.3.3 by what percentage would you need to **increase sales revenue** to make E-commerce financially attractive? [ ]

4.4 Were you influenced in your adoption of E-commerce by your competitors? Y / N

If Y, are these existing or new competitors (multi-choice)?

Existing Y / N New Y / N

4.5 When do you believe E-commerce will become the 'norm' in your sector for the following:

– marketing	NOW	or	☐☐☐☐
– purchasing	NOW	or	☐☐☐☐
– sales	NOW	or	☐☐☐☐
– post sales	NOW	or	☐☐☐☐

5. Barriers (categories A, B and C)

5.1 (Category C only) Since you have no current intention to adopt E-commerce, could you give the main reasons:

a) Wait and see ________________

b) Security ________________

c) Privacy ________________

d) Cost ________________

e) Other, please specify ________________

Would you also be able to comment on the following?

5.2 Do you have the facility/ability to carry out encryption techniques on data etc.?: Y / N

If Yes, then what method of encryption do you use? ________________

What do you use this for, is it
a) data transfer Y / N
b) authorisation Y / N
c) other, please specify ________________

Do you use encryption for the following
a) Intranet/internal Y / N
b) Extranet/externally Y / N
c) both Y / N
d) other, please specify ________________

5.3 Finally, are there any other opinions or comments about E-commerce you would like to express?

____

____

____

6. IT infrastructure

6.1 How many IT staff are employed at your site?

6.2 How many PCs do you have on site?

6.3 What proportion of them have the following:

CD-ROMs?
Modems?
are laptops?

6.4 Of those that are laptops, what proportion are Internet-enabled?

7. Respondent details

In conclusion, may I just check the following information about you and your organisation?

Project code	*Project code (text 10) [pre filled]*	Source ID	*Source ID (text 50) [pre filled]*
Company name	*Company name (text 50)*	Telephone	*Telephone (text 20)*
Address	*Address 1 (text 50)*	Fax	*Fax (text 20)*
	Address 2 (text 50)		
	Address 3 (text 50)		
Town/city	*Town/City (text 30)*		
County	*Region (text 30)*		
Postal code	*Postal code (text 10)*		
Country	*Country (text 30)*		

	Respondent 1	**Respondent 2 (if applicable)**
Title	*Title (text 10)*	*Title (text 10)*
First name	*First name (text 30)*	*First name (text 30)*
Surname	*Surname (text 30)*	*Surname (text 30)*
Job title	*Job title (text 30)*	*Job title (text 30)*
Direct line	*Telephone direct (text 20)*	*Telephone direct (text 20)*
Direct e-mail	*Email direct (text 60)*	*Email direct (text 60)*

Background information *(✔ one only)*

Market sector: NACE groups

finance	(65-67)
utilities	(64, 40, 41)
retail/wholesale	(50-52)
transport/travel	(62, 63, 64, 12)
discrete manuf.	(28-36)
business services	(70-73)
other services	(74)
government	(75)

Head office status *HO status (Y / N)*

Total staff at site *Staff site (number)*

8. Thank you

Many thanks for your assistance. We will be posting the main conclusions of this survey on our Web site. You will be able to find a peer-to-peer comparison. We will notify you by E-mail when this is available.

The ICT market in Central and Eastern Europe

This paper has been provided by IDC in close co-operation with the EITO Task Force.

1. Economic and ICT environment

Introduction

It is now approaching ten years since the fall of the Berlin Wall and the revolutionary events which changed the face of Central and Eastern Europe. While economic and political troubles have abounded, most of the states in the region have made the initial transition to parliamentary democracies and market economies. This is particularly true of the countries of Central Europe, where successful elections have led to relatively smooth transitions of power and the emergence of a new civic culture. Growing political stability combined with evolving market economies, economic growth, the ongoing privatisation of state-owned industries and potential membership of several states in organisations such as the European Union and NATO have radically transformed the environmental framework for doing business in the region. The states of the region have now reached an important juncture in terms of future developments as the new millennium approaches.

This study has a particular focus on major ICT market developments in those five Central European countries undergoing accession talks as part of the European Union's Agenda 2000, including the Czech Republic, Estonia, Hungary, Poland and Slovenia. The market of Slovakia is also examined in order to provide a more comprehensive overview of developments throughout the Central European states. The paper also addresses Russia in view of the country's sheer size and importance to this regional ICT market. The overall ICT statistics for these countries are included in Part Three, Statistical outlook, *tables 28* to *34, 37, 54* to *60* and *63.*

Moreover, an overview of terminology and abbreviations used throughout is located at the end of this document.

An equally important challenge for countries in Central and Eastern Europe is establishing the necessary ICT infrastructure to maintain stability and economic growth. Many have already taken a number of steps to reform their respective regulatory and legislative environments to encourage investment in key sectors such as public administration, banking/financial services and telecommunications. Much of their activity is focused on devising procedures for IT strategy development, procurement and implementation at both the regional and national levels, which conform to the requirements set out in the European Union's Agenda 2000 Programme and the attendant Information Society.

Thriving local IT markets have also led to the emergence of a nascent industry in Central and Eastern Europe for the design, development, manufacture and sale of IT products, both locally and abroad. Several countries have seen the appearance of local software companies which are developing, patenting and marketing packaged solutions throughout the

Table 1
Overview of membership in selected international organisations for the countries of Central and Eastern Europe

Organisation	CZ	SK	PO	R	HU	EST	SL
World Trade Organisation (WTO)	●	●	●	○	●	○	●
Euro-Atlantic Partnership Council Member	●	●	●	●	●	●	●
North Atlantic Treaty Organisation Accession Programme	●		●		●		
European Union (EU) Associated Membership	●	●	●		●	●	●
International Labour Organisation (ILO)	●	●	●	●	●	●	●
Central European Free Trade Agreement (CEFTA)	●	●	●		●		●
Organisation for Economic Co-operation and Development (OECD)	●		●		●		

○ = Observer status

world. An even larger number of software programmers from Central and Eastern Europe provide development support for software houses in the European Union and the United States. Moreover, a number of international IT companies have either set up manufacturing facilities in the region for hardware production, or established dedicated software development companies. Several local firms have also patented their own hardware products.

1.1. Czech Republic

1.1.1. Economic trends

The Czech Republic now faces a period of economic stagnation brought on in part by nearly two years of political uncertainty. Growth in GDP slowed to 1.2% in 1997, and the current account balance moved to a 6.2% deficit. Estimates for 1998 GDP will be close to 2.5%. Although GDP actually contracted in the first two quarters of the year, exports and imports were up by around 30%. Combined with a gradual recovery in private and public consumption, healthy export levels are likely to generate GDP growth of 2.5% in 1999.

Unemployment is also rising, climbing to nearly 6% of the workforce in 1998 after remaining well below 3% for most of the period up to 1995. It is projected to increase slightly in 1999 as restructuring forces both local companies and public sector organisations to shed further employees.

On the positive side, inflation has generally remained below 10%, falling to 8.5% in 1997. Inflation pressures grew in 1998 due in part to a deregulation of state-controlled prices in areas such as utilities and an increase in taxation. The rate is likely to border on 10% for the year.

A major challenge for the government is the reform of the country's banking and financial services sector. The largest Czech banks showed major losses through the middle of 1998, due to a combination of poor debt portfolios, defaults on loans by large state industrial companies, insufficient reserves and the financial crisis in Russia.

Despite recent official efforts to introduce incentives to attract foreign direct investment, including five year tax holidays and customs-free zones, there is still some reluctance to invest in the Czech economy. Overall investment for 1998 is projected to be under ECU 0.8 billion, compared to ECU 1.02 billion in the previous year. Total cumulative FDI through the first part of 1999 is unlikely to exceed ECU 7 billion. This figure is less than half of total FDI in Hungary, and only a third of the level of investment in Poland.

Table 2 a
Overview of basic economic indicators for Central and Eastern Europe

		1995	1996	1997	1998*
Czech Republic	Nominal GDP (billion ECU)	39.1	44.5	41.7	
	GDP per capita PPP (ECU)	7,464	8,841	9,118	0
	GDP (% change)	4.8	3.9	1.0	2.5
	Industrial production (% change)	8.7	6.8	4.5	4.0
	Budget balance (% of GDP)	0.4	- 0.1	- 0.5	- 0.2
	Unemployment (%)	2.9	3.5	4.5	6.0
	Inflation (%)	9.1	8.8	8.5	10.0
	Exports (billion ECU)	17.0	17.3	17.7	22.5
	Imports (billion ECU)	19.9	21.8	21.3	28.0
	Trade balance (billion ECU)	- 2.8	- 4.6	- 3.5	
	Current-account balance (billion ECU)	- 1.1	- 3.5	- 2.5	
	Population (m)	10.3	10.3	10.3	10.3
Hungary	Nominal GDP (billion ECU)	34.4	35.3	35.4	
	GDP per capita PPP (ECU)	5,166	5,392	5,743	
	GDP (% change)	1.5	1.3	4.4	4.0
	Industrial production (% change)	4.6	2.3	10.9	9.0
	Budget balance (% of GDP)	- 6.5	- 1.9	- 2.1	- 5.0
	Unemployment (%)	11.1	10.7	10.8	9.0
	Inflation (%)	28.2	23.6	18.3	13.0
	Exports (billion ECU)	10.2	10.3	15.0	20.7
	Imports (billion ECU)	12.1	12.8	16.5	23.7
	Trade balance (billion ECU)	- 2.0	- 2.4	- 1.6	
	Current-account balance (billion ECU)	- 2.0	- 1.3	- 0.8	
	Population (m)	10.2	10.2	10.2	10.2
Poland	Nominal GDP (billion ECU)	91.9	105.9	107.0	
	GDP per capita PPP (ECU)	4,297	4,629	5,047	
	GDP (% change)	7.0	6.1	6.9	5.0
	Industrial production (% change)	9.7	8.5	11.4	8.0
	Budget balance (% of GDP)	- 3.6	- 2.5	- 1.4	- 1.8
	Unemployment (%)	14.9	13.6	10.5	11.5
	Inflation (%)	27.8	19.9	15.3	12.0
	Exports (billion ECU)	18.0	19.2	21.4	31.5
	Imports (billion ECU)	22.9	25.7	30.3	45.0
	Trade balance (billion ECU)	- 4.9	- 6.5	- 8.9	
	Current-account balance (billion ECU)	4.3	- 1.1	- 3.4	
	Population (m)	38.6	38.6	38.6	39.1
Russia	Nominal GDP (billion ECU)	278.6	346.8	364.4	
	GDP per capita PPP (ECU)	3,445	3,344	3,436	
	GDP (% change)	- 4.2	- 4.9	0.4	
	Industrial production (% change)	- 3.3	- 5.0	2.6	
	Budget balance (% of GDP)	- 5.5	- 7.7	- 6.8	
	Unemployment (%)	8.8	9.3	10.0	
	Inflation (%)	47.6	14.7	11.5	
	Exports (billion ECU)	62.9	70.2	61.7	
	Imports (billion ECU)	36.8	49.1	46.2	
	Trade balance (billion ECU)	26.2	21.2	15.6	
	Current-account balance (billion ECU)	7.5	9.2	7.4	
	Population (m)	148	147.5	148.2	

* Forecasted

Table 2 b
Overview of basic economic indicators for Central and Eastern Europe

		1995	1996	1997	1998*
Slovakia	Nominal GDP (billion ECU)	13.6	14.8	15.4	
	GDP per capita PPP (ECU)	5,751	6,238	6,763	
	GDP (% change)	6.8	6.6	6.5	3.0
	Industrial production (% change)	8.3	2.5	2.0	2.0
	Budget balance (% of GDP)	0.1	- 4.4	- 5.7	- 6.0
	Unemployment (%)	13.1	12.8	12.5	14.0
	Inflation (%)	9.9	5.8	6.1	7.0
	Exports (billion ECU)	6.8	6.9	6.9	9.8
	Imports (billion ECU)	6.9	8.7	8.1	11.5
	Trade balance (billion ECU)	- 0.2	- 1.8	- 1.2	
	Current-account balance (billion ECU)	0.3	- 1.6	- 1.0	
	Population (m)	5.3	5.3	5.4	5.4
Slovenia	Nominal GDP (billion ECU)	14.7	14.9	13.8	
	GDP per capita PPP (ECU)	8,319	8,701	9,164	
	GDP (% change)	4.1	3.1	2.9	3.5
	Industrial production (% change)	2.0	1.0	1.3	2.0
	Budget balance (% of GDP)	0.0	- 0.3	- 1.5	- 0.7
	Unemployment (%)	14.5	14.4	14.8	14.0
	Inflation (%)	12.6	9.9	8.4	8.0
	Exports (billion ECU)	6.5	6.5	6.6	9.02
	Imports (billion ECU)	7.5	7.4	7.4	10.37
	Trade balance (billion ECU)	- 0.9	- 0.9	- 0.8	
	Current-account balance (billion ECU)	0.0	0.0	0.1	
	Population (m)	2.0	2.0	2.0	2.0
Estonia	Nominal GDP (billion ECU)	2.8	3.5	3.7	5.5
	GDP per capita PPP (ECU)	0.0	0.0	0.0	
	GDP (% change)	4.3	4.0	11.0	7.0
	Industrial production (% change)	4.7	6.3	12.0	10.0
	Budget balance (% of GDP)	- 1.2	- 1.5	- 0.5	0.0
	Unemployment (%)	5.1	5.6	4.9	1.0
	Inflation (%)	29.0	23.2	11.2	9.0
	Exports (billion ECU)	1.5	1.6	2.0	n.a.
	Imports (billion ECU)	2.0	2.4	3.1	n.a.
	Trade balance (billion ECU)	- 0.5	- 0.9	- 1.1	n.a.
	Current-account balance (billion ECU)	0.0	0.0	0.0	
	Population (m)			1.5	1.5

* Forecasted

1.1.2. Regulatory and legislative factors impacting the ICT market

Concrete policies to promote ICT investment in the Czech Republic have been limited. Some factors impacting on ICT market development include the following:

- A government-wide information system (USIS) remains a relevant topic in the Czech Republic, despite an absence of funding for such a venture. The Czech Parliament discussed a new law in June 1998 concerning a computerisation strategy for the public sector. Government departments continue to invest in and build their own information systems, oftentimes incompatible with solutions in other state organisations. The government invests up to ECU 82 million annually for IT projects in various departments (national only).

- The Telecommunications Act of 1964 was amended in 1992 in order to separate the regulatory role of the government from the operational role of the existing state operation company (SPT). In August 1994, the Czech government adopted a comprehensive policy for the telecommunications sector, consisting of (1) the partial privatisation of the SPT with a strategic partner and a voice monopoly, (2) licensing of two mobile telephone networks using the pan-European digital standard (GSM), and (3) the licensing of new local operators in sixteen localities. As part of WTO negotiations in 1997, the Czech government has committed itself to liberalising the market for fixed network and voice telephony by 1 January 2000.
- Efforts were made to lower import duties for information technology in 1998. All import duties are to be abolished for computer products and telecommunications equipment by the year 2002.
- A draft copyright and intellectual property rights law is under preparation at the Czech Ministry of Culture with the goal of standardising on EU norms. The ministry's draft is aimed to bring Czech legislation into line with the latest international cyber guidelines from the WIPO.
- The Association of IT Companies (Sdruzeni pro informacni spolecnost) began activities in March 1998. Founded with 21 local firms, the organisation is seeking to represent the common interests of IT vendors in government and state administration. It has set the following goals: (1) to follow the integration process with the European Union, (2) support local entrepreneurship, and (3) enhance the general knowledge of Czech citizens about IT.

1.2. Hungary

1.2.1. Economic trends

The crisis in Russia along with a potential slowdown in growth in the EU may dampen the ongoing recovery of the Hungarian economy which moved strongly forward in the 1997-1998 period on the basis of rising output and declining inflation.

The harsh austerity measures of the government's Bokros plan from 1995 set the stage for economic recovery and growth in the 1997-1998 period. While only a small growth of 1.3% was seen in the economy in 1996, expansion took place in 1997 on the basis of higher exports and improved internal demand. GDP already rose by 4.4% in 1997, and with growth bordering on 4% in 1998, based on an increase in investment, and rising exports. While the Hungarian economy may slow somewhat in the 1999-2000 period, GDP growth is likely to exceed 3%.

Hungary has succeeded in trimming the current account balance, having reduced the deficit for three consecutive years. While exports continue to rise, the country continues to suffer from negative trade balances due to high imports. In 1997, the trade deficit was reduced to only ECU 1.6 billion. A slight rise to ECU 1.73 billion is expected for 1998. After falling to 2.2% of GDP in 1997, the current account deficit attained nearly a 3% rate in 1998. Hungary still retains the highest per capita debt in Europe. Gross debt stood at ECU 20.7 billion at the end of 1997.

Foreign direct investment in Hungary remains strong. According to the Privatisation Research Institute, foreign investment totalled ECU 1.5 billion in 1996, down from ECU 3.54 billion in 1995. FDI is believed to have attained a further ECU 1.58 billion in 1997, bringing the cumulative total capital investment to ECU 13.4 billion.

While the rate of inflation has been traditionally high in Hungary, the annualised figure has fallen steadily over the last several years. Peaking at 28.2% in 1995, growth in the Consumer Price Index (CPI) declined to only 18.3% in 1997. It is projected to hover around 13% in 1998.

The expansion in economic output has also carried over into the labour market. The unemployment rate fell to 10.8% in 1997 and declined to only 8.9% by September 1998.

1.2.2. Regulatory and legislative factors impacting the ICT market

The Hungarian government has become one of the most proactive supporters of information and communications technology development in the region in the wake of an expanding economy. Efforts have been under way to match the accession criteria established by the EU, to enhance the technical and ICT skills of the general population, and to promote research and development in technologies such as software and telecommunications. Several factors impact on ICT market development:

- While no specific ministry is responsible for overall IT development, the Hungarian government has established an Interdepartmental Committee within the Prime Minister's Office whose role is (1) to identify strategic IT directions in compliance with the standardisation requirements of the European Union, and (2) to supervise the development and application of a unified information system in central government administration.
- At the end of March 1997, a special Government Committee, co-chaired by two Hungarian ministers, was established to co-ordinate developments in the field of information technologies and telecommunications related to the government sector.
- An indiscriminate custom tax on imported goods was eliminated on July 1, 1997. This tax was originally introduced as an 8% duty on March 20, 1995. The change means that there is no tariff on hardware components sourced from the European Union. The rate of duty remains 8% on hardware components coming from Far East countries.
- The Hungarian government launched a Modernisation Programme in 1998 containing measures to support "teleworking". Also, its Provinces Modernisation Programme contains components for so-called "Tele-Houses" in Hungary. Through mid-year 1998, up to 28 telehouses were already operating in Hungary, and up to 60 additional ones are under development. Over the next year, a further one hundred are to be established as part of the Country TeleHouses Programme.
- The Hungarian government has also ventured into the sphere of public data information systems and networks, having introduced a National Information Infrastructure Programme (NIIFD) for the development of country-wide networking capabilities to provide as many users as possible with access to database resources. The programme is supported by a number of organisations including the Hungarian Academy of Sciences (MTA), the National Technical Development Committee (OMFB), the National Scientific Research Fund (OTKA) and the Higher Education Development Fund (MKM).
- In 1995, the government also introduced policy regulations for public procurement with the Act of Public Investment (közbeszerzés) which centralised purchases and mandated that (1) all public sector projects must be tendered and (2) final decisions should reflect the least expensive solution.

- In June 1998, the Directorate of Public Investment Board of the Prime Minister's Office announced the list of companies which were awarded the rights to deliver computers and IT services (i.e. large Public Investment Tenders) for central government budget-based purchasing (nearly 900 organisations) in the July 1998-December 1999 time period.
- The Ministry of Education launched a special school computerisation programme called SuliNet whose aim was to install an Internet connection in every secondary school by the end of August 1998. The project covers more than 1,200 schools and includes data transmission (with 64 kbps; rented lines, ISDN, satellite connection); school-networks (1 Web-server, 6-8 client systems, and 10,000 PC units), NOS, software for preparing Web-pages); training materials; teacher-training (6,000-10,000 people); and a common training database development. The Ministry dedicated ECU 43 million for the first three years of the project.
- The Hungarian government has passed a number of laws focused on liberalising the telecommunications sector. Legislative and regulatory instruments comprise the Telecommunications Law of 1992; the Frequency Management Law of 1993; the decree of 1993 on Licensing and on the general conditions for services of telecommunications operators; the Law of 1995 on type approval of telecommunications equipment; and the decree of 1997 on licensing those services for which the market has already been liberalised (e.g. data transmission, multimedia etc.). The majority of the capital of the public network operator MATÀV has been privatised. Three mobile operators have been licensed, all of which represent joint ventures between Hungarian and Western investors.

1.3. Poland

1.3.1. Economic trends

Poland's economy is undergoing a period of recovery and expansion. It first began booming in 1994 when growth in GDP reached 5.2%. Figures for successive years include 7% (1995), 6.1% (1996) and 6.9% (1997). With GDP growth slowing in the second half of 1998, due in part to the crisis in Russia, expansion is likely to fall to the 5% range.

Although exports performed well in 1998, import growth continued to surpass that for exports with the consequence that the trade deficit surged. The trade deficit exceeded ECU 8.9 billion in 1997, and grew to an estimated ECU 11 billion the following year. As a consequence, the current account deficit has expanded, rising to more than 3% of GDP.

The current account balance though has been buoyed by notable foreign direct investment. Poland has now become the leading recipient of FDI in the region, as it moves into the privatisation of strategic sectors such as energy and telecommunications. Total cumulative foreign direct investment exceeded ECU 9.5 billion in 1996, reflecting a ECU 4.1 billion leap on the 1995 year-end figure. Total FDI exceeded ECU 3.5 billion in 1997, with the establishment of several large investment projects including ECU 0.8 billion for a greenfield automobile factory. Projections for 1998 call for a further ECU 4.7 billion in FDI. It is estimated that Poland will have received up to ECU 23.6 billion foreign direct investment by the year 2000.

The government budget deficit was also down to 1.4% in 1997, having fallen for several consecutive years. This figure could fall as low as 1.1% in 1998. The ruling coalition agreed to a 2.15% budget target for 1999.

The rate of unemployment remains problematic despite falling around 10.5% in 1997.

Concerns over employment have undermined efforts by the government coalition to privatise key industrial sectors such as steel and chemicals.

The Polish government has also succeeded in reducing inflation which fell to only 15.3% for 1997. It was projected to decline to 12% per annum in 1998.

Debate has surfaced within the government concerning the pace of privatisation. Some are seeking to speed up privatisation of key sectors through the year 2000, with the aim of expanding the private sector's share of GDP by selling nearly 100 targeted state firms.

1.3.2. Regulatory and legislative factors impacting the ICT market

In the 1993-1998 period, the Polish government has become a major purchaser of information technology, including hardware, software telecommunications and professional services. It has also taken an active role in both the computerisation of the public sector, with the establishment of several organisations to oversee IT procurement. Moreover, its monetary and fiscal policies and regulations have had substantial impact on the evolution of the country's information technology market.

- In the early 1990s, Poland saw the emergence of several official organisations which are now closely involved in the computerisation of the public sector. Most important was the Office for Information Technology at the Bureau for the Council of Ministers (BIURM), the government's steering committee for IT development created in 1991, which sought to formulate IT directions and strategies for public administration. Many of the BIURM's tasks have now been passed over to the Ministry of Interior Affairs and Administration. As a consequence, each governmental agency or ministry now has its own IT budget, in accordance with the specifications of the annual state budget.

Table 3
Major ICT projects in the government administration sector in Poland, 1994-1998

Ministry	Project name	Start date	ECU (Mio.)
Finance	POLTAX	1994	63
Interior	DUTY	1995	79
Labor & Social Affairs	ALSO	1996	n.a.
Interior	National Police	1998	32
Labor & Social Affairs	ZUS	1998	213

- Over the last several years, the government has devised plans for a three-tiered computerisation of public administration focused on national administrative units, local districts (voivodship), and municipal organisations (gmina). Initial priority has been given to central organisations. Several of the largest projects to date are summarised in *Table 3.*
- In 1998, the Ministry of Education allocated a budget of ECU 23.6 million for an IT programme entitled "Internet in Gminas' Grammar Schools". The programme's goal is to connect at least one grammar school PC laboratory of each of the over 2,500 gminas in Poland to the Internet. Ministry budget will be granted for purchase of 10 PCs, 2 printers, 1 modem and 12 educational software packages per site. In addition to the Ministry's budget, each gmina is obligated to spend a minimum of ECU 2,360 for teachers' training. Software and hardware purchases will be organised centrally in the form of ten open tenders.
- Pesel-Net (nationwide ID registry network) was activated in 1998. The network is to connect voivoidship local councils, passport offices, and citizens' registries to the central database of the Ministry of Interior and Administration. The network relies on twelve backbone nodes connected by digital links leased from TPSA.

- Introduced in 1994, the Certification Act requires that some products, including consumer electronics, undergo an electromagnetic distortion test and be certified by the Polish Center for Testing and Certification (PCBC). On July 21, 1994, Rada ds. Badan i Certyfikacji published a list of products requiring the so-called B Safety Certificate. The list included IT products such as PCs, notebooks, printers, monitors, and components.
- The Polish Communications Act enacted in 1990 created a new legal body (Telekomunikacja Polsa - Spolka Akcyjna) for the national operator and liberalised licensing. Therewith, licences were issued to a number of operators for local services. The TPSA retains exclusive rights to long distance and international markets until 1999 and 2003 respectively.
- A new Telecommunications Law was drafted for presentation to the Polish Parliament in September 1998. The aim of the legislation is to bring the country's telecommunications sector in line with the European Union and create a fully independent regulator. At this time, the government also approved a proposal to privatise the public operator TPSA.
- First established in 1993, the Polish Chamber of Information Technology and Telecommunications functions as a quasi-advisory body on information technology policy development in the public sector. Representing up to 160 IT companies, its many activities include (1) lobbying the Sejm, the Senate and various government ministries, (2) participating in the activities of the Council of Information Technology, (3) reviewing and advising on customs tariffs and tax regulations concerning ICT, (4) sponsoring and supporting ICT events, exhibits and conferences, and (5) representing member firms in the public sector.

1.4. Slovenia

1.4.1. Economic trends

Slovenia retains the highest credit ratings in the region, as well as the highest GDP per capita. It was around 70% of the European Union average in 1997, at ECU 13,000.

The economic outlook for the country continues to be favourable with GDP projected to grow by 3-4% in 1998, after rising by an average of 3% in the 1996-1997 period. Moreover, the government has kept a tight rein on spending, and it plans to reduce the budget deficit from 0.9% in 1998 to 0.8% next year. Inflation is also low by regional standards, averaging slightly less than 9% in the 1996-1998 period, and it is projected to fall below 7% next year. Finally, while the country has more recently seen a deterioration in the current account balance, the deficit is unlikely to exceed 1% in 1999.

The main challenge for the Slovenian government in the 1998-1999 period will be to introduce reforms consistent with eventual membership in the European Union, to revise the country's pension system, to restructure the banking system and finally to introduce a value-added tax.

1.4.2. Regulatory and legislative factors impacting the ICT market

Much of the more recent regulatory and legislative factors impacting on ICT market development in Slovenia centre around the country's eventual membership in the European Union. Eventual integration requires a number of necessary adjustments to current IT infrastructure in state administration, as well as the establishment of standards. Some of the most important policy developments include the following:

- The Slovenian government appointed the Government Centre for Informatics (GCI) to be responsible for the implementation, planning, development, consultation and formulation of methodological and technological solutions for a the informatics infrastructure of state organisations.

- The GCI drafted a paper entitled the "Strategy for providing the state bodies of the Republic of Slovenia with an information infrastructure by the year 2000", which was adopted by the Slovenian government in 1996.
- Slovenia has among the lowest tariffs for imported IT hardware in Central Europe. This has promoted strong growth in the personal computer market. Imported components are taxed at approximately 4 % for customs duties. Once hardware is sold within the country, a 5% sales tax is passed on to the end-user. Nevertheless, in order to meet European Union membership criteria, by the year 2000 the country must introduce VAT, which is expected to be approximately 22%.
- Slovenia's central bank has proposed a strategy to control inward investment, which was expected to be approximately ECU 158 million in 1998. This represents a decline of 23% compared to 1997.
- In June 1997, the Slovenian government passed the Telecommunications Act which liberalised all services apart from voice telephony and network infrastructure, which remain the monopoly of Telekom Slovenije until the year 2000. The legislation provides a framework for access to networks, mobile telephony and the granting of licences. There is currently one GSM operator in the country, Mobitel, although provisions were made in the Telecommunications Act to license two additional operators.
- At the outset of 1998, the government began discussion on a bill concerning the privatisation of 74% of Telekom Slovenije.

1.5. Estonia

1.5.1. Economic trends

Estonia has pursued a radical free market economic reform programme in Central and Eastern Europe. While the crisis in Russia has had some impact on the country's economy, it has continued to grow remarkably, due in part to a reorientation of trade towards Western Europe and the United States. GDP is estimated to have grown by 7% in 1998, down from 11% growth the previous year.

Measures have been taken to counter what was potentially an overheated economy by reducing the country's current account deficit, strengthening the Kroon, and reforming the banking sector. Despite a 10% growth in exports, the trade deficit exceeded 13% of GDP in the 1997-1998 period, due largely to strong local demand for imported consumer goods. Nonetheless, the Kroon has remained relatively stabile due to the commitment of the country's currency board to a solid currency, a liberal trade regime and a balanced budget.

Efforts to reduce the current account deficit and retain the position of the Kroon have enabled the government to rein in potential growth in inflation. Growth in the consumer price index was limited to around 10% in the 1997-1998 period.

The banking sector represents the one problematic area of the economy. In an effort to counter weaknesses in this sector and curb easy lending, the Estonian central bank introduced measures for tighter supervision in 1998 such as raising the capital-adequacy ratios.

Estonia remains the most popular site for investment among the three Baltic countries, with nearly ECU 0.78 billion in foreign direct investment through the first part of 1998. In

1997, there were nearly 70,000 firms registered in the country, including 5,000 with foreign capital participation.

Between 1993-1997, 472 state enterprises were sold through the tender method for a total of ECU 249 million. The transactions created jobs for over 56,000 people. Privatisation priorities for 1998 were the privatisation of power generation ("Estonian Energy"), telecommunications ("Estonian Telecom"), and railways ("Estonian Railways").

1.5.2. Regulatory and legislative factors impacting the ICT market

The Estonian government has undertaken a number of steps to liberalise the regulatory and legislative environment for ICT market development and growth:

- The Estonian Council of Informatics promotes the computerisation of public administration, as well as local scientific research projects and the certification of local IT companies. Its tasks comprise the following: (1) establishing the organsational and legal framework for national information policies, (2) planning research and development activities in the field of information sciences, (3) overseeing international co-operation in the field of information technology and (4) developing an integrated policy for data services.
- From 1993 to 1997, the Estonian Informatics Center organised 52 tenders for IT procurement as summarised in *Table 4*. The Ministry of Finance proposed ECU 7.9 million in IT investment for 1998.
- Estonia has also seen the establishment of a National Standards Board to oversee the development and implementation of standards including those for information technology. The central organisation is the EIF which introduced the first national IT standards in 1993.

Table 4
Overview of the number of public sector IT tenders in Estonia, 1993-1997

Year	Number of tenders	Value (ECU Mio.)
1993-1994	13	1.23
1995	21	1.57
1996	18	1.53
1997	27	2.32
Total	79	6.65

Source: Estonian Council of Informatics

- A law on regulations for public procurement was passed in 1993. It specifies regulations for purchasing IT equipment and services through open tenders. Companies seeking to compete for public tenders must receive official certification.
- In 1997, the government adopted legislation to sell 49% of shares in Eesti Telekom (Estonian Telecom Limited). ETL owns majority shares in all state-owned telecommunications companies including Eesti Telefoni (Estonian Telephone Company - ETC), Eesti Mobiltelefoni, Estonian Paging, Telemedia Eesti and Esdata. The Finish firm Baltic Tele retains a minority stake in the country's main PTO, Eesti Telefoni. National and fixed-line telephony is the monopoly of ETC until December 2000.
- In 1998, the Ministry of Transport and Communications drafted a new telecommunications law to harmonise legislation with that of the European Union. This represents a follow on to a telecommunications law enacted in 1991 which provided the basis for a policy of liberalisation and licensing. The more recent legislation will make the Inspectorate of Telecommunications an independent regulator.

1.6. Slovakia

1.6.1. Economic trends

The Slovak economy performed relatively well throughout the 1997-1998 period. While GDP growth has slowed due to a fall in exports, it still reached 6.5% in 1997, and declined to 3% in 1998. Expansion was fueled by a rise in domestic demand with in 8.3% increase in real wages.

The current account deficit has reached a level which may threaten the stability of the Koruna and requires correction. After falling to 7% in 1997, the deficit climbed to nearly 9% in 1998, due to increased consumption of imported goods and the strength of the Koruna. A relatively stable currency upheld by tight monetary policy and increasing nominal wages has led to a boom in consumer spending. Efforts to increase the level of FDI (only ECU 158 million in 1997) and the introduction of a 7% import surcharge have seen only marginal success in containing growth in the annual deficit. A devaluation in the early part of 1999 is now likely.

The Slovakian central bank has been committed to defending the Koruna to maintain its stability while limiting inflation. As a consequence, the country boasts one of the lowest inflation rates in the region 6.1% in 1997, rising to an estimated 7% in 1998.

1.6.2. Regulatory and legislative factors impacting the ICT market

While the Slovakian government represents one of the chief sources of information technology spending, most regulatory and legislative initiatives have been confined to fiscal policy measures to generate tax revenue. Moreover, no specific body is responsible for IT strategy development and management. Factors influencing the country's ICT market include the following:

- In light of a severe decline in foreign direct investment, the government introduced a new ten-year tax exemption for foreign investors. The initiative is intended to attract international firms interested in investing capital in domestic companies and their infrastructure.
- Many large state-run organisations will be an important market for batch shipments of personal computers, printers and packaged software in the short term. For the past five years the companies have been mandated by law to use hardware purchased in 1992 and before through the year 1996. In 1997, however, some funding became available permitting these groups to update their existing IT infrastructures. Although shipments will increase gradually, due to financing concerns, end-users in this sector are expected to be an important component of demand through the year 2000.
- In an effort to lower imports, a 7% tariff was applied on all products. As a result, upon introduction, imported hardware became more expensive and local companies were left with the option to assume the costs or raise prices.
- As of January 1998, VAT (6-23%) was approved which will further increase the price for all goods including software and hardware.
- Originally implemented to curb imports into the country, a law was passed concerning the electronic certification of ICT products to conform to EU standards. The government has ordered every electronic product from televisions to personal computers to be certified by a Slovak agency. In addition to costing several hundreds of dollars per item, the most problematic aspect is the time of certification. In general, goods must be submitted for up to a two-month period and may not be sold during this period of time without substantial penalties.

- In January 1996, Slovenske Telekomunikacie (ST) was created from the government's Post, Telecommunications and Research department. The national PTO was given a monopoly on public network infrastructure and voice telephony services until 2003.
- A revised telecommunications law is presently being prepared to replace the current Telecommunications Act which dates from 1964. The new legislation will align Slovakia's telecommunications sector with EU directives and will end the incumbent PTO's monopoly on voice services by 2002 at the latest.
- The government also awarded two licences for GSM services in September 1996.

1.7. Russia

1.7.1. Economic trends

After managing to maintain two years of relative stability in the value of the Rouble against the US Dollar, in mid-August 1998 the Russian government and the Central Bank were forced to abandon their policy of supporting the Rouble. The consequence was a precipitous decline in the value of the Russian currency which fell from 6.5 to the US Dollar in mid August to 25 later in the month. With the introduction of strict Central Bank controls on how Russian commercial banks can buy and sell foreign currency, by October the currency had stabilized at around 16 to the Dollar.

The rate of inflation averaged between 11 and 15% in Russia prior to the currency crisis in August 1998. During August and September inflation rose to 43%.

In 1997, the consolidated federal, regional and local deficit was about 4% of GDP. Prior to the August financial crisis the Russia government had set itself a target of a deficit of 5% in 1998. Nevertheless, declining world prices for oil and gas combined with a wholesale retreat by foreign investors left Russia with a huge shortfall in its current account. Russia now has one of the lowest credit ratings in Europe. In 1999, the country faces an extremely tough year in terms of debt repayments.

The result of the August crisis was that the country's already shaky banking system effectively ceased to operate. Most of the top tier commercial banks were effectively bankrupted by the combined effects of the freezing of the GKO market, the rush by all depositors to withdraw their money and by the collapse of the value of the Rouble. Though banks in default on loans worth millions of US Dollars have still not been declared officially bankrupt, it is expected that these events will prompt an overhaul of the banking system which will involve the disqualification of hundreds of banks in 1999.

Direct foreign investment in Russia in 1997 totalled ECU 1.6 billion - a figure widely regarded as tiny for a country of this size. The main barriers to foreign investment are the absence of an adequate law on property (and mechanisms for its enforcement) and the unpredictability of local administrations and taxation authorities whose behaviour has been known to be corrupt and arbitrary.

As a result of shrinking industrial output, Russia has recorded negative GDP growth rates every year since independence until 1997 when the country recorded its first positive GDP growth at 0.4%. Although this trend continued into early 1998, the August crisis arrested any further positive developments. In the wake of the August 1998 crisis, GDP was predicted to fall 4% for the year. This negative growth rate can be expected to worsen in 1999.

In mid-1998, the number of people unemployed was officially said to be 6.66 million, or 9.3% of the workforce. Nevertheless, official statistics do not account for the large number of people who are formally employed but receive no salary. Following the August crisis levels of real unemployment, especially in Moscow, have severely increased.

In 1997, the Russian government finally managed to sell off a stake in Sviazinvest - a holding company controlling the government's stakes in all local telephone operators. In parallel many local telecoms operators launched fund raising drives on foreign equity markets. A second government stake in Sviazinvest was due to be auctioned off in October 1998 but due to the financial crisis this was cancelled.

1.7.2. Regulatory and legislative factors impacting the ICT market

The Russian state is highly fragmented and as a result it has proved impossible for any part of it to develop and enforce concrete national ICT policies or directives. The collapse of the Soviet Union left several federal bodies with some form of national ICT responsibility but only limited effects. Goskomsvyazi (the State Committee on Communications and Information) is formally responsible for ICT strategy in Russia.

- Goskomsvyazi was formed in 1996 after the Ministry of Communications was abolished. Its role has been largely regulatory and its influence felt mostly the telecommunications sector. Its initiatives in the ICT sector so far have been limited to a programme called "A Computer for Every Family" announced in October 1997. Nothing ever came of the initiative.
- There is, however, no shortage of regulatory bodies with responsibility for ICT products. All products (including ICT products) sold in Russia must be approved by Rostest. All data encryption products or any products sold to state sector customers must also be approved by the Federal Agency for Governmental Communications and Information (FAPSI).
- Each Russian government ministry invests under its own agenda. The most coherent ICT investment strategies have been undertaken by individual institutions. For example the Savings Bank of Russian and GazProm (both majority state-owned) are the two largest IT customer organisations in Russia. Each are rolling out huge IT investment strategies of their own.
- Other large public investment strategies have been guided by World Bank loans. Since 1994 investments by the Ministry of Social Security, the Federal Pension Fund, the State Election Committee, the Central Bank, the State Customs Committee, The State Committee for Land Resources, The State Tax Police (and others) have all been prompted and influenced by World Bank loans. World Bank loans are linked to specific projects and some loans have had an IT requirement. As is the case with most World Bank loans, money loaned has to be matched with investment by the receiving government.
- Russian taxation legislation is oftentimes unclear and arbitrary and contains very high rates of turnover tax which tend to penalise manufacturers. This has been a particularly important factor in the area of direct foreign investment in the ICT sector.
- Today there are no major investments in computer hardware manufacturing or assembly in Russia, due largely to local tax legislation and import-export regulations. All imports of computer equipment and components are liable to a 20% sales tax which is charged on all goods as they enter the country and passed on the customers at the point of sale. Systems are also subject to a further 10% import duty and the import duty on components averages from 8-9%.

Table 5
Overview of European Union Accession Programme for Selected Central European Countries

Month	Year	Activity
July	1997	Agenda 2000
August-December	1997	Accession Partnerships established
December	1997	Luxembourg Summit: vote on Agenda 2000
February	1998	European Conference: new Europe celebration
March-April	1998	Launch of accession talks
December	1998	First Accession Partnership review
December	1999	Second Accession Partnership review
January	2000	Implementation of new agricultural and structural fund programmes
?	2001	End of accession talks
?	2003	Final ratification period
?	2004	Entry of new members

Source: European Commission

- Russia has a reasonably well drafted law on Intellectual Property which was passed in 1994. Rights to intellectual property, however, are still widely flouted in Russia. Enforcement of this law depends largely on the position taken by a city administration and who the proposed target of any legal action may be. From January 1998, the sanctions contained in Russian legislation applying to companies and individuals infringing rights of intellectual property became significantly harsher and easier for the authorities to enforce.
- In April 1997, the government signed a decree providing for the sale of 49% of the stock of Svyazinvest. The decree called for the government to transfer its stakes in four other operators – Rostelecom, Central Telegraph, Ekaterinburg Telephone Network and Gibrosvyaz – to Svyazinvest prior to its partial privatisation. The sale was scheduled to occur in two stages: firstly, the tender of a 25% stake to domestic and foreign investors in August and secondly, the sale through private negotiations of a 24% stake to Russian investors.
- In 1998, the Committee on Telecommunications and Mass Media of the Moscow City Government issued an edict entitled "Regulations on issuing permission for sale of video, audio, and computer media, elements of their packaging and identification". According to the regulations, it will be illegal to sell the above-mentioned products, which includes computer software, in Moscow without the necessary permission of the Committee. This action may make life very difficult for software pirates – however, feedback from computer companies specialising in software development and sales indicates that the regulations may also add unwelcome bureaucracy for legitimate vendors.

1.8. The impact of European integration on the ICT markets of Central and Eastern Europe

An increasingly important aspect of IT development in the Eastern European region is the function of international organisations and the international lending community in providing finance, direction and support. The European Union, in particular, is playing a key role in offering much-needed assistance in devising standards and policies while allocating financial resources through such organisations as the EIB (European Investment Bank) and the EBRD (European Bank for Reconstruction and Development) for the computerisation of public administration, transportation, environmental protection, energy and other areas of basic infrastructure. It has also become the leading partner for foreign trade in the region.

The basis for the European Union's relations with the states of Central and Eastern Europe is the associated status accorded to many of them from 1991 onwards. Individual Association Agreements entailed four general areas of co-operation as the first steps toward eventual membership, including trade, financial support, investment and industrial development, and political.

In June 1993, the European Council summit in Copenhagen adopted the criteria for membership to be applied to the countries of Central and Eastern Europe. Membership was determined to require: (1) stable institutions guaranteeing democracy, the rule of law, human rights and the protection of minorities, (2) the existence of a functioning market economy, as well as the capacity to cope with competitive market pressures in the Union, and (3) the ability to take on obligations of membership including adherence to the aims of political, economic and monetary union, i.e. the acquis. In July 1997, the European Commission determined as part of its Agenda 2000 proposal that five of the ten Central European candidates for eventual membership were selected for accession talks and the development of a pre-accession strategy. They include the Czech Republic, Estonia, Hungary, Poland and Slovenia.

At its meeting in Luxembourg in December 1997, the Council decided that Accession Partnerships represented the chief instrument for providing all forms of possible assistance to the applicant countries within a single framework. Their purpose is to establish a single framework for priority areas for further work identified by the European Commission's Opinions on the applications of various countries in the region for membership in the Union. Accession Partnerships also provide a framework for various policy instruments which will assist candidate countries in their preparations for membership.

In its goal to oversee compliance with the principles set out the in Copenhagen summit, the Accession Partnership programme has established priorities and objectives for prospective members, based on the Opinions of the Commission. They consist largely of steps for making the necessary changes in regulations and legislation to confirm to the Union's acquis. Integral to the objectives set for most countries is implementation and application of information technology as a tool to strengthen institutions and the development of competitive market economies.

The Opinions of the Commission themselves contain a specific section on "Innovation", subsumed under the "Ability to Assume the Obligations of Membership", which focuses on the legal and regulatory framework for telecommunications, audio-visual technologies, research and technological development, and education.

Throughout, potential members are recommended within the context of the Information Society to undertake the following:

- to adapt to EU laws in the area of ICT;
- to adopt EU standards for ICT and the harmonisation of current ones;
- to reorganise and develop telecommunications networks according to EU standards;
- to work out detailed concepts for the development of information processes (legal basis, standards, public data network);
- to create the nucleus of an information environment (public data transmission networks, main information registers, databases of geographical, legal etc. data);
- to develop individual information systems influencing a country's economy;
- to prepare proposals for developing IS for state services.

In support of these goals the Union has developed a number of instruments for technical and financial assistance to potential members such as the following:

- *E-commerce and Central and Eastern European countries* (CEECs): In the light of the future full participation of CEEC organisations in the 5th FP the European Commission DG III is encouraging the exchange of ideas, experiences and know-how between EU Member States and the CEEC countries.
- *Inco-Copernicus:* is a European Commission programme for scientific and technological co-operation with the countries of Central Europe (CCE) and new independent states (NIS).
- *Phare* is a European Commission programme for Central and Eastern Europe (Albania, Bosnia and Herzegovina, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, Macedonia) which is focused on providing funding and technical assistance for a set of "core" activities including economic restructuring, privatisation, labour market reform, public administration development, financial services and training. A notable portion of investment is directed toward information technology.
- *Tacis* is a European Commission initiative which provides grant finance for know-how to foster the development of market economies and democratic societies in the new independent states (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan and Mongolia).
- *East-west scientific and technological co-operation:* the European Commission has approved a wide variety of research projects over the last several years within the context of programmes such as TEMPUS.

All accession countries have entered agreements for full participation in the Fifth Framework Programme for R&D.

The Commission has also made the establishment of trans-European communication networks a major goal for ICT development in Europe. To this end, it has launched several pan-European key initiatives in the domain of interchange of data between administration (IDA programme), electronic data interchange (EDI), mobile communications (GSM, ERMES), satellite communication (e.g. TDMA), and basic infrastructure (ISDN and IBC) generic services and applications.

2. ICT markets

Introduction

Central and Eastern Europe's economic and political transformation has also carried over into developments in the region's information technology and telecommunications markets. Once driven by the basic demand for hardware to compensate for years of minimal investment in obsolete technology, many markets of the region have now moved into a second, more mature stage of development in which user requirements have shifted to the implementation of relevant solutions to operate more efficiently and profitably in a market economy. As a consequence, spending on packaged software, IT services and communications technologies has increased sharply.

Despite considerable economic problems and the first signs of market maturation, the region of Central and Eastern Europe continues to represent one of the most dynamic ICT markets in the world. Ongoing programmes to develop and modernise both industry and a broad range of services, such as basic infrastructure for banking/finance, insurance, retail, and government administration, combined with the demands of an evolving private sector, will ensure substantial ICT market growth well into the next century. While total spending on ICT in 1998 declined by 1.3% to an estimated ECU 22.4 billion, due largely to the crisis in Russia and market stagnation in the Czech Republic, stronger demand can be expected as the region's economies move to further stability and growth.

Major drivers of ICT market growth in Central and Eastern Europe include the following:

Large-scale public infrastructure projects: Major investment in ICT in the region continues to be driven by large-scale infrastructure projects in sectors such as government administration, banking/financial services, insurance, telecommunications and manufacturing.

Emergence of a dynamic private sector market: The transition to market economies in the region has led to an explosion in the number of small and medium-sized private companies operating in the region. They currently represent a major source of investment in personal computers, peripherals, networking and packaged software.

Re-structuring/cost-cutting measures: Since the opening of the region's economies in the early 1990s, local companies have been under considerable pressure to restructure and change operations in order to become more efficient and enhance competitiveness as they operate in the new market economy. This development has also carried over into investment in the range of IT products and services.

Technological change: With technology changing at a staggering rate, local IT departments are finding it more difficult to acquire and maintain skills. Companies in the region are increasingly turning towards external providers to implement new systems and technologies (e.g. client-server application suites, Internet/Intranet, networking solutions and custom software solutions etc.).

Year 2000 problem: While the Year 2000 problem has received less attention in Central and Eastern Europe than in the West, the growing awareness of this exceptional issue is moving users to seek outside support. The compulsory nature of this issue and the fixed compliance time scale mean that local IT departments must either postpone other developments until this problem has been solved, or contract an external provider.

Growing popularity of packaged software solutions: While piracy and price sensitivity remain major issues, users in Central and Eastern Europe are now investing more in legal operating systems and packaged applications, such as

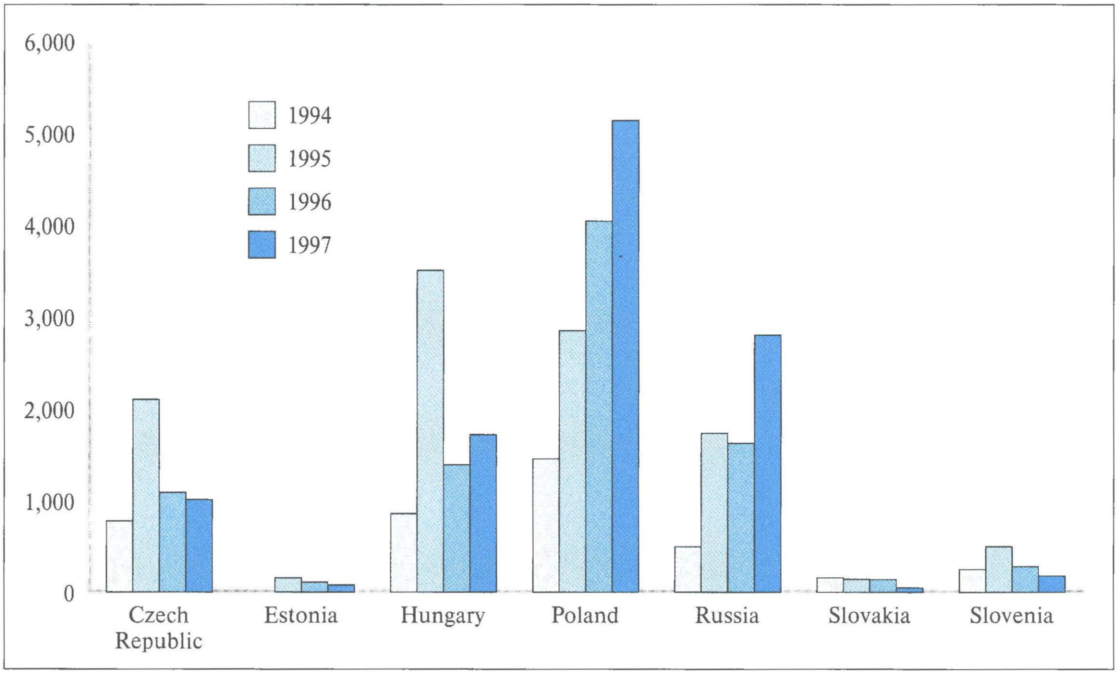


Figure 1
Overview of foreign direct investment in Central and Eastern Europe, million ECU, 1994-1997

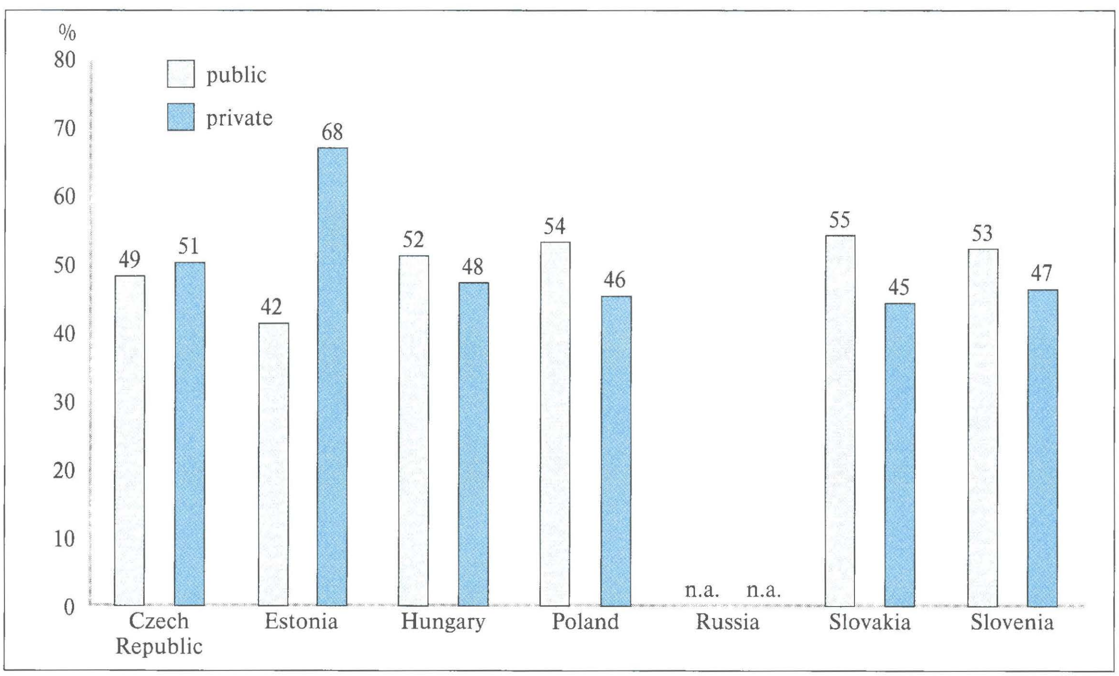


Figure 2
Overview of the private sector's share of GDP in Central and Eastern Europe, 1997

client-server business solutions, integrated Enterprise Resource Planning (ERP) software and other cross industry applications.

Internet/Intranet growth: While the number of actual Internet users in Central and Eastern Europe remains low, it represents one of the hottest topics in the regional IT market. Both the number of providers and users have mushroomed, and most local IT news coverage is now devoted to this topic. Moreover, local IT companies are reorganising and revising product strategies to move into this segment, particularly for implementation and support. Localisation of Internet-related products has become an important business for many local software firms.

Proliferation of networking: The Central and Eastern European region has also seen a surge in the demand for internetworking hardware, servers, network consulting, implementation and management services. The higher penetration of LANs, combined with growth of Windows NT installations and ongoing upgrades of NetWare users to IntranetWare, are also driving notable demand for hardware and networking support services.

Demand for complex professional services: The growing complexity of solutions combined with implementation of new technologies such as the Internet has facilitated the emergence of an increasingly dynamic market for IT services.

Telecommunications modernisation: notable investment has taken place in all segments of the region's telecommunications markets since 1991. Nonetheless, teledensity is still low, at much less than half the levels found in Western Europe. The growing demand for data and information services such as the Internet, call centres, teleconferencing and collaborative computing will require even higher levels of investment into the next century. Growth in the mobile telephony market has also been explosive.

While spending on information technology has grown remarkably over the last five years, both the relationship of IT expenditures to GDP and per capita IT spending reveal that expenditures are still considerably lower than that of the average country market of Western Europe. *Figure 4* illustrates that only the Czech Republic and Estonia exhibit spending levels which match those of most Western European countries: the vast majority of Central and Eastern European states spend less than 2% annually on information technology. Similarly, per capita spending across the region is quite low, from the Czech Republic's high of approximately ECU 116 in 1997 to Russia's ECU 20. There is still considerable pent-up demand for information and communications technology throughout the economies of Central and Eastern Europe.

2.1. Country market comparison

While substantial growth is generally being recorded in all markets of Central and Eastern Europe, important differences exist among the various countries in terms of development and the demand for specific ICT technologies. Indeed, while the markets of Russia and Poland offer the greatest potential, ICT vendor activity is largely confined to sales of personal computers, printers, office equipment and related technologies. Nonetheless, both markets are poised for eventual strong growth in demand for packaged software and IT services. Smaller countries such as Hungary, the Czech Republic, Slovakia, Estonia and Slovenia offer more sophisticated markets in terms of the type of systems, communications and services required.

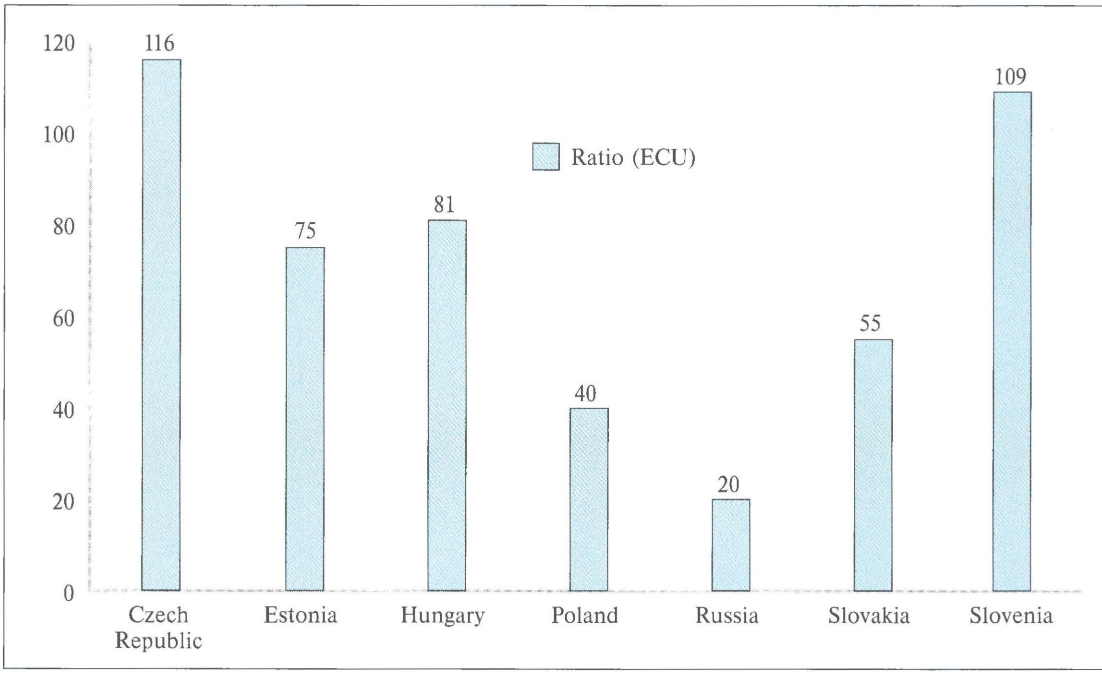


Figure 3
IT per capita in Central and Eastern Europe, 1997

Figure 4
IT/GDP in Central and Eastern Europe, 1997

2.1.1. Czech Republic

The Czech Republic continues to offer one of the most dynamic information technology markets among the countries of Central and Eastern Europe in terms of relative size. This can be seen from an examination of IT ratios for the country, which are now beginning to reflect spending patterns in Western European markets in which IT expenditures are being shifted to implementation services, networking hardware/software, application solutions development and support. Moreover, the country retains the highest ratio of IT per capita spending in the region (1997: ECU 116). ICT spending levels as a percentage of the country's GDP are also comparable to those of most Western European countries. Finally, it has the largest IT services market in the region.

Table 6
Comparison of ICT and GDP growth rates, 1997-1999

Country		1997/96 %	1998/97 %	1999/98 %
Czech Republic	ICT	11.0	11.9	12.8
	GDP	1.0	2.5	
Estonia	ICT	12.4	13.2	14.1
	GDP	11.0	7.0	
Hungary	ICT	11.8	8.9	9.8
	GDP	4.4	4.0	
Poland	ICT	19.1	19.9	17.3
	GDP	6.9	5.0	
Russia	ICT	14.3	- 19.2	- 14.2
	GDP	0.4	3.0	
Slovakia	ICT	7.2	8.0	10.6
	GDP	6.5	3.0	
Slovenia	ICT	8.1	10.6	9.7
	GDP	2.9	3.5	

In 1998 total ICT market value rose by nearly 12% to ECU 3.4 billion due largely to greater spending on software, services and telecommunications, as revenue from IT hardware sales declined.

However, there is a slowdown in the Czech market across most hardware categories, particularly for personal computers, servers and related technologies. The PC market has not grown in unit terms since 1996, hovering around 230,000 to 240,000 units in annual sales, while market value has plunged in the face of falling average system prices. Similarly, the systems/server and workstation markets have seen no growth in revenue over the last two years. The market for peripherals has also declined in both unit and value terms. Sectors which continued to see increased demand included IT services, packaged software, datacommunications and telecommunications. Even here, however, the high growth rates reported for previous years were scaled back.

The ICT market in the Czech Republic is expected to increase in value by an annual growth rate bordering on 13% through the year 2000. The value of the market will exceed ECU 4.2 billion through the end of the forecast period. While most spending will remain focused on hardware, software and services will comprise an increasingly larger share of annual ICT expenditures. Particularly strong areas of growth aside from personal computers include networking hardware/software, LAN servers, networking services (implementation/management), software application development, professional services and customer support services. Major investment will also continue in telecommunications.

The telecommunications market expanded by 16% in 1998 to reach ECU 2 billion. The local operator SPT Telecom has been comparatively successful in increasing the number of telephone lines installed. It built 460,000 new lines in 1997 (of which 94,000 were for businesses), bringing its total to 3.28 million by the end of the year, and has a target of 500,000 in 1998. Penetration rates in the Czech Republic are now 32 lines per 100 inhabitants and 81 lines per 100 households. SPT Telecom is committed to a target of 43 lines per 100 inhabitants by the year 2000.

The penetration of mobile services in the Czech Republic had passed 5 subscribers per 100 inhabitants by the end of 1997 after rapid growth during the year. As of the end of March 1998 there were 700,000 subscribers representing a penetration rate of 6.8% of the population. The competition between the rival operators has brought down the cost of mobile telephony and significantly extended the market into the consumer segment.

Factors driving ICT market growth in the short term include (1) the rise in the number of companies implementing packaged application solutions, both locally developed and standard

ERP packages, (2) the Internet and emerging E-commerce, (3) the trend to share resources through networking, (4) growing demand for IT services, and (5) ongoing investment in upgrading telecommunications infrastructure. Lower expenditures in government administration, ongoing delays in privatising the country's major banks, lower GDP growth and falling real wages will dampen demand for ICT. A key issue is the demise of the banking sector as a major recipient of ICT, in the face of eventual privatisation, and as lower profits have impacted dramatically on the level of investment.

2.1.2. Hungary

The ICT market has shown a remarkable recovery in the 1997-1998 period in the face of an expanding economy and notable foreign direct investment. Spending on ICT in 1998 grew to ECU 2.7 billion, marking a 9% rise over the previous year. Stronger demand was posted for all segments of the market, with the highest growth recorded for LAN hardware, midrange servers, application software, implementation services and telecommunications.

Other factors contributing to ICT market growth aside from a strong economy and rising wages include an increase in spending in key sectors such as public administration and banking/financial services, the implementation of several large projects such as the Ministry of Education's Sulinet programme, the growing popularity of the Internet, notable investment in packaged application solutions such as ERP software, a major trend toward networking, significant investment in both public and private network communications, a booming market for mobile telephony and increased requirements for IT services support among local users.

As one of the more developed markets of Central Europe, spending on information and communications technology in Hungary is now less focused on basic hardware. In 1998, expenditures on computer hardware, office and data communications equipment and LAN technology comprised only 18% share of the total ICT market, while spending on software, professional services and support services rose to 16%. Much of the growth in hardware has been confined to sales of personal computers, PC LAN servers and LAN internetworking, as demand for systems (high-performance mainframes, Unix servers and SMP servers) has stagnated. Sales of personal computers rebounded in the 1997-1998 period, rising to nearly 170,000 units for ECU 166 million in revenue last year. While Unix-based midrange systems continue to generate the largest share of server revenue, PC servers running Windows NT now represent the platform of choice for multi-user applications.

Software and services have become an important factor in the country's information technology market over the last three years. These two categories currently illustrate the highest level of annual growth, with combined revenue reaching an estimated ECU 422 million for 1998. Professional services and systems integration, in particular, have seen a flurry of activity, with most major international PS vendors taking up operations in this market. Moreover, several large outsourcing contracts have been awarded in the 1997-1998 period. Hungary also retains a notable local software industry focused on exports.

Growth in the Hungarian telecommunications market has been dynamic over the last several years. In 1998, spending in this category reached ECU 1.76 million, marking 10% growth over the previous year. The local operator MATÁV has increased the number of phone lines it operates from 1.3 million at the end of 1993 to 3.1 million at the beginning of 1998, resulting in a reduction in its waiting list for installation of lines from 785,000 to less than 20,000, thus fulfilling the quota pledged in 1993 as part of its concession contract. The number of lines per 100 inhabitants in Hungary has risen from 14 in 1993 to 30.5 at the beginning of 1998 and is expected to reach 35 within the next three years. The main objectives of telecoms development strategy in Hungary are now shifting away from increasing telephone penetration and towards improving business communication services. MATÁV will invest ECU 393 million annually until the year 2000 but this will be channelled primarily into new services with only 40% going into network development. The Hungarian PTO trebled the number of its ISDN lines in 1997 to reach 38,500.

Growth in the Hungarian mobile market slowed down considerably in the second half of 1997 after doubling in 1996. There were 700,000 mobile subscribers in Hungary as of January 1998.

Hungary's ICT market is expected to grow at an annual rate of around 9% in terms of value through 2000. Most vendor activity will be confined to the low end of the market, in particular to personal computers, PC servers, desktop software applications, peripherals, datacommunications hardware and office equipment items. Market growth through 2000 will stem largely from four vertical markets: the evolving small and medium-sized private company sector, banking/financial services, manufacturing and government administration. Moreover, the energy and telecommunications segments are becoming increasingly more important for higher-end equipment sales.

2.1.3. Poland

Successive years of strong economic growth, a sharp rise in foreign direct investment, and the implementation of large scale ICT infrastructure projects in sectors such as government administration and banking/financial services have provided a boost to ICT spending in Poland. Overall expenditures in this country market reached an estimated ECU 5.7 billion in 1998, which marked a 19.9% increase over the previous year's figure of ECU 4.7 million.

Growth in the Polish IT market is being driven by several factors aside from general investment and economic growth including a surge in the demand for LAN internetworking technology consistent with the proliferation of networking, ongoing strong sales of personal computers and related technologies, an evolving Internet market, increased requirements for IT professional and support services and the implementation of standard packaged application solutions. As the IT hardware market consists largely of PCs and related technologies, most software and services vendor activity is focused on sales and support of packaged software, customised applications development, networking and hardware/software support services.

In 1998, demand was up sharply for almost all ICT categories with the exception of Unix servers. The country's personal computer market continues to generate the bulk of spending, having reached nearly 580,000 units for ECU 577 million in revenue last year. Similar growth was documented for servers, with most demand focused low-end PC-based LAN servers running Windows NT. Nonetheless, LAN hardware, software and IT services represented the strongest growing market segments in the 1997-1998 period, with particularly strong demand seen for application software, implementation services and IT consulting.

Growth in the telecommunications market has been consistent with developments in the IT market. In 1998, spending on telecommunications is estimated to have grown to ECU 3.9 billion. The national operator TPSA installed over 800,000 new connections in 1996 and about 900,000 in 1997 after investing a total of ECU 1.77 billion. As of March 1998 the total was 7.6 million mainlines, representing a penetration rate of nearly 20%. At this pace though it will take 10 years to reach the current European average telephone penetration. The waiting list for installation of a telephone line is still around three years. TPSA plans on investing ECU 0.9 billion annually in network development. It will maintain its current investment programme aimed at installing 1 million new lines a year but will increasingly focus away from growth in numbers and towards quality. The company also wants to invest more in data transmission, broadband networks and improvements in the efficiency of the current network.

Poland's mobile market was marked in 1997 by high growth rates and rapid network expansion. Nevertheless, it has a current penetration rate of just over 2%, which is low in comparison with other countries in the region. As of January 1998, there were nearly 860,000 subscribers to mobile telephony in the country.

Poland's ICT market will continue to develop rapidly in the years ahead, with a projected average growth rate of 15% through 2000 in terms of value. While strong demand for basic hardware will persist, an increasingly larger share of spending will be devoted to software and services.

2.1.4. Slovenia

Slovenia traditionally presided over the most developed IT market of the former Yugoslavia with a relatively large number of mainframes, minicomputers and corresponding networks. The country also served as the gateway for IT distribution to other Yugoslav republics. Today, Slovenia represents one of the most mature IT markets in Central and Eastern Europe which is reflected in the fact that, despite its small size with only 2 million inhabitants, the total value of the country's ICT market rivals that of several larger countries such as Croatia, Romania and Slovakia. The country also has one of the highest per capita spending levels in the region.

Despite delays in passing the government's fiscal budget, the ICT market in Slovenia grew by 10.6% in 1998 to ECU 838 million. While higher demand was seen for software and services, IT hardware continued to account for the largest share of spending last year. The ICT market remains focused on personal computers and related technologies: sales of PCs rose by 13% to more than 65,000 units for ECU 75 million in revenue. Demand was particularly strong among small and medium-sized businesses which accounted for nearly 40% of sales. Slovenia also offers one of the strongest home PC markets in region (17% of sales in 1998), which reflects the relatively high per capita salary of its citizens (more than ECU 7,800 per year). The server market on average grew 0.5% in 1998, with the major increase coming from low-end PC servers running Windows NT.

The software and services markets are being driven by greater demand for networking, packaged application solutions and implementation support. The Internet also represents an important market driver: Slovenia has the highest ratio of PCs connected to the Internet in the region.

Spending on telecommunications was also up notably in the 1997-1998 period, based on investment in fixed-line capacity and mobile telephony. Evidence of the success of network modernisation in the country is the fact that Telekom Slovenije connected its 700,000th telephone subscriber in November 1997. Representing a penetration rate of 36 lines per 100 inhabitants, this is the highest in Central and Eastern Europe. Digitalisation of its network had reached 59% by mid-1997. Nevertheless, faced with the prospect of competition in public voice services, the national PTO invested ECU 115 million in network infrastructure in 1998, a 20% increase from the previous year. It is seeking to raise telephone penetration to 40% by the year 2000 and to achieve 100% digitalisation some time between 2000 and 2003. ISDN services were introduced in 1995 and Telekom Slovenije also provides frame relay and Internet services. ATM trials began in 1997.

The local mobile operator Mobitel launched its analogue NMT-450 service in July 1991 and now covers 95% of the country's population with 42,000 subscribers. The Mobitel GSM service began in July 1996 and covers 80% of the population. Subscriber numbers have grown rapidly to reach more than 45,000 by January 1998. The total penetration rate of the two services is 4.5% and is expected to grow to 10% by the year 2000.

The Slovenian ICT market is projected to grow by 9.6% annually through the year 2000. As with other markets in the region, a shift to software, services and communications can be expected.

2.1.5. Estonia

Estonia represents one of the smallest ICT markets in Central and Eastern Europe. Total spending on all hardware, software, services and telecommunications in the country reached an estimated ECU 419 million in 1998. Most ICT demand was confined to personal computers and related technologies. PC shipments rose to 44,000 units for a market value of ECU 43 million.

At one time, Estonia fielded an installed base of 360 multi-user systems (mainframes and minicomputers) inherited from Soviet times. Much of this equipment was discarded with the complete restructuring of Estonian industry. Today, multi-user system sales are limited chiefly to PC servers. While some demand for midrange Unix and even high-performance systems can be found in sectors such as banking, science/education and government administration, low-end LAN servers represent sufficient capacity for IT requirements of the 70,000 small and medium-sized companies which have evolved in this market since independence.

The Estonian ICT market is largely a local one, dominated by a small number of companies focused on personal computers and related technologies. Approximately ten local firms form the basis of a PC assembly industry, led by companies such as Microlink and Pennu Computer Technology. Several sources indicate that there are approximately 300 local information technology firms active in the country.

The most important vertical markets in Estonia include banking/financial services, government administration, telecommunications and the evolving private company sector. The government remains one of the leading investors in ICT with the support of organisations such as the Estonian Informatics Fund. The country's remaining banks also represent important sources of ICT demand. The largest banks and the Estonian National Bank were already connected to SWIFT in 1992.

Like their Scandinavian neighbours, Estonians have already developed a reputation for being avid users of the Internet, with one of the highest penetration rates in Central and Eastern Europe. Since establishing a permanent Internet connection in 1992, Estonia has concentrated on connecting commercial users, libraries, schools, universities and other institutions to the Internet. The government has played a leading role in matching the funds of private Western donors to suitable projects and in making the issue a national priority. In these efforts, it has been relatively successful; for example, it is estimated that nearly 50% of all secondary schools in the country now have some level of connectivity. The government also created EEnet, the Estonian Educational and Research Network. This now serves many of the nation's schools, cultural institutions, libraries and both government and non-governmental institutions. Commercial activities are beginning to make their way onto the Internet with three banks now offering Internet banking. Finally, a nationwide network of 40 computer booths, marked by giant white-on-blue signs, offer Internet access along the countries major highways.

Growth in the telecommunications market in Estonia is being driven big fixed-line and mobile telephony development. At the end of 1997, there were 469,000 telephone lines in the country, representing a penetration rate of 32% (i.e. 32 lines per 100 inhabitants). Up to 38% of the total number of lines were connected to digital exchanges with a rate of around 50% in the capital Tallinn. Fixed-line penetration is expected to rise to 43% by the year 2000. Digitalisation is expected to have reached more than 60 at this time. ETC plans to install 42,000 new digital connections a year and a further 25,000 replacing analogue connections (through an investment of ECU 151 million) through the year 2001. An SDH transmission backbone went into operation in 1997 while an ATM connection between Tallinn and Helsinki was inaugurated in November of that year. More than 4,000 km of fibre-optic cable have now been laid in Estonia. As well as upgrading its ISDN, X.25 and Internet services, ETC is planning to employ wireless local loop systems to provide service in rural areas of the country.

Estonia will undoubtedly become the first country in Central and Eastern Europe to reach mobile penetration levels in line with those in Western Europe. The expansion of the market during the 1997-1998 period was dramatic. At the start of 1997, there were two operators with four networks and just over 60,000 subscribers between them. By the end of the year the total subscriber base had risen to over 150,000. With a total of 178,000 subscribers at the beginning of May 1998, Estonia's mobile penetration rate of over 12% is now close to that of France and Germany.

2.1.6. Slovakia

Slovakia stands out among the smaller countries of Central and Eastern Europe for the relative size of its ICT market. Vendor activity has traditionally been focused on meeting the requirements of infrastructure development in the banking/financial services and government administration sectors, as well as large, state run companies. In 1998, the country's evolving small and medium-sized business private sector became a more important source of ICT shipments. Sales to these segments compensated for a fall off in demand among state organisations and banks last year in the run up to September elections.

Despite a growing economy and a stable currency, the Slovakian market has stagnated for the last two years in the face of cutbacks on ICT spending in key sectors such as government administration. In fact, several major projects that were scheduled to be delivered in the 1997-1998 period were either delayed, or postponed indefinitely, due in part to budgetary problems. In 1998, the total value of all ICT expenditures reached an estimated ECU 1.1 billion, consisting largely of sales of personal computers and related technologies, and telecommunications. Only minor recovery is expected in view of ongoing political problems and a potential slowdown in the economy.

In 1998, the personal computer market in Slovakia grew by nearly 5% to more than 65,000 units. The value of sales also recovered after declining in the 1996-1997 period, reaching ECU 79 million in revenue. The Windows NT segment was the only one to grow last year among server categories, despite the popularity of Unix in larger accounts. Overall demand, however, was lower for servers with the demise of the project market. Segments posting notable growth last year included application solutions, IT consulting and implementation services.

With more demand being seen for software and services, several local companies have initiated moves to offer consulting and/or specialised software applications in order to offset the rapidly decreasing margins associated with pure hardware and software sales. In the 1997-1998 period, many large corporate customers began selecting firms that could not only provide extensive regional coverage, but also "complete solutions" within specified project frameworks. Several IT providers reported increased sales of hardware due to their ability to offer comprehensive services.

At the beginning of 1998 Slovenské Telekomunikácie (ST) received an ECU 100 million loan from the European Investment Bank which will be used to expand and digitalise the country's network. At the end of 1997, the penetration rate for fixed-line telephones was a little under 26% with an average waiting time of over a year for installation of a new line. Digitalisation of the network had reached 44% by June 1997. ST plans to increase the penetration rate of telephone lines to 35% and the rate of digitalisation to 78% by the year 2000.

The mobile market in Slovakia benefited in 1997 from the launch of two rival GSM services following the awarding of two licences in September 1996 to the incumbent analogue operator EuroTel Bratislava and a consortium called SlovTel. The number of mobile subscribers increased significantly during 1997 to reach a penetration rate of around 4%. Further strong growth occurred in 1998 resulting in significant development of the consumer market.

The fortunes of the Slovakian ICT market in the 1999-2000 period will depend largely on developments in key vertical market sectors. Nonetheless, many large accounts are already saturated with hardware: spending will increasingly shift to software and services to put this large base to the most efficient use. Any growth will also depend on the ability of the new government to draw more foreign direct investment into the country, particularly in the manufacturing sector. The country's economy is visibly linked to political stability and a weak government coalition promises uncertainty not only within the domestic business environment but also for foreign direct investors. Slovakia's ICT is projected to expand at an average rate of 10% through 2000.

2.1.7. Russia

After illustrating notable growth of 14% in 1997, the Russian ICT market contracted by more than 19% to 8.4 billion ECU in 1998. The major economic and political crisis brought an abrupt halt to spending in key sectors such as government administration and banking/financial services. The immediate result of the mid-year credit squeeze on the Russian government was that a large proportion of budget obligations were simply not met, which produced a dramatic fall in demand for ICT products among state institutions. As a consequence, many large scale projects under way for organisations such as the Russian Taxation Inspectorate, the Russian Taxation Police, the Ministry of Transport and Communications and the State Pension Fund were stopped. Moreover, many state sector customers failed to pay for IT equipment already shipped, causing a major strain on the cash-flow of several local ICT companies.

The market's problems have not only been restricted to the state (i.e. directly budget-supported) sector. Due to the fact that the state budget acts as a catalyst for spending in many other sectors, spending on ICT fell sharply throughout the economy.

The ICT market slump has also affected the more complex and affluent markets in Moscow and St Petersburg – with retail sales significantly down year on year. Similarly, the market's contraction has influenced all players in the local ICT industry alike: international brands, large local OEMs, small local OEMs, distributors, resellers etc. all experienced a dramatic decline in revenue.

The economic crisis also undermined sales of ICT equipment to the home and small business/small office segments as the value of the Rouble plunged and banks froze both private and commercial accounts. Compounding such problems was a notable increase in the attention the State Tax Police have been paying to large and medium-sized companies. Since it cannot raise the debt financing it needs the Russian government has been in involved in a desperate bid to raise this money from the population. In the PC business several of Russia's largest computer companies are rumoured to have been subject to rigorous "checks" by the taxation authorities. Such checks have often frozen the business operations of these companies for some time.

The PC segment remained the most active in a depressed market. Shipments of personal computers declined to only 848,000 units last year, which was down by more than 38% over the previous year. A similar development characterised the markets for printers, office equipment, servers, LAN hardware and storage devices. Overall, hardware remained the major focus of IT spending in 1998, accounting for more than 80% of expenditures.

The demise in the large project business also undermined the demand for software and services, two segments which had illustrated sharp growth through 1997. Activity in these sectors generated ECU 445 million in revenue in 1998, which was down by 14% over the previous year. Once the economy illustrates some signs of recovery and funding becomes available in the state sector, strong growth can be expected for application solutions and implementation and networking services. A number of vendors of desktop applications and business solutions (e.g. ERP) had already reported record revenue for the country prior to the mid-1998 crisis.

While a number of international software vendors have entered this market, their operations are limited in scope due to the extensive black market for pirated software and the large pool of local programmers. Price concerns and local attitudes also play a role here, as considerably more local software development is taking place, either internally, or on a custom basis. Many international vendors rely upon the support of the large local integrators and value-added resellers which have emerged over the last several years. Several have signed agreements with local firms for software research, development and programming.

Although the development and modernisation of the Russian telecoms services market have been rapid, it is still a long way behind international standards, particularly in the remote regions of the country. The number of access lines per 100 inhabitants reached 19 in 1997, significantly lower than the more advanced markets in Central and Eastern Europe. Nearly 8% of the population is awaiting the installation of a telephone line and in many regions unmet demand exceeds the existing number of access lines.

The first Russian cellular networks were launched in 1991 in Moscow and St Petersburg, which are the most developed markets in the country. At the end of March 1998, the Russian cellular market comprised 92,500 NMT subscribers on 48 networks; 91,000 GSM subscribers on 22 networks and 128,000 AMPS/D-AMPS subscribers on 42 networks. The large number of networks is a result of the government issuing regional rather than national licences.

A crisis of confidence will impact on the Russian ICT market in the short term. A bad situation is made worse by the fact that ICT demand is particularly vulnerable to the mood of the moment since both customers and ICT companies are historically used to violent swings of fortune. Nevertheless, some recovery

Table 7
Overview of information and communications technology spending in Central and Eastern Europe by category, 1998, million ECU

Country	Computer hardware	Office equipment	Data-communi-cations	Software	Services	Telecom equipment	Telecom services	Total ICT market
Czech Republic	485	61	95	168	462	935	1,145	3,351
Estonia	69	6	13	18	13	130	171	419
Hungary	356	55	57	142	280	561	1,199	2,649
Poland	946	95	123	211	393	1,017	2,876	5,662
Russia	1,339	291	124	140	305	2,799	3,400	8,399
Slovakia	156	20	21	52	63	348	435	1,094
Slovenia	126	14	17	42	44	263	332	838
Total	3,477	542	450	773	1,560	6,053	9,558	22,412

is in sight in the 1999-2000 period. The most important sectors of ICT market growth continue to be represented by financial services, government administration (statistics, tax/customs, revenue collection and Central Bank operations), basic infrastructure (energy and transportation), telecommunications and manufacturing. In the short term, demand in the banking sector will be expected. Moreover, it can be expected that a significant amount of installed equipment in banks will now be put on the market. Demand will pick up once again among private companies and home users once the Rouble stabilises and credit becomes available.

2.2. ICT category comparison

While demand for basic hardware remains strong, particularly in the larger markets of the region further East such as Russia and Poland, a growing amount of annual IT expenditures are now being generated from sales of datacommunications, software, professional services and maintenance/support services. *Table 7* illustrates, however, that this regional market is still largely oriented to basic computer and telecommunications hardware which accounted for nearly 47% of ICT spending in 1998.

2.2.1. IT hardware

The countries of Central and Eastern Europe have spent the last decade investing in basic information technologies to establish infrastructure and to compensate for the deficits in spending of the communist era. As a consequence, the region's IT markets remain heavily oriented to basic IT hardware such as personal computers and PC-related technologies (PC add-ons, peripherals), which accounted for the largest percentage of IT spending in the 1997-1998 period. Similarly, other segments such as low-end office equipment, LAN internetworking hardware and the LAN server market have experienced considerable growth over the last several years. In 1998, IT hardware comprised ECU 4.4 billion in revenue for 19.7% of the total ICT market.

2.2.2. Personal computers

Personal computers represent the overriding driving force of demand for information technology in Central and Eastern Europe. Shipments of PCs in the countries examined in this survey have averaged 16% annual growth in unit terms in the 1995-1998 period. The boom in regional PC sales reflects a number of factors

Country	IT hardware
Czech Republic	642
Estonia	88
Hungary	468
Poland	1,165
Russia	1,754
Slovakia	197
Slovenia	157
Total	4,471

Table 8
Overview of the information technology hardware market in Central and Eastern Europe by country, 1998, million ECU

including the relatively low installed base of machines, notable investment in IT by small and medium-sized enterprises from the services sector, rising real wages which are influencing demand among home users, major IT investment projects in sectors such as public administration, insurance, banking/financial services and manufacturing, and general economic growth.

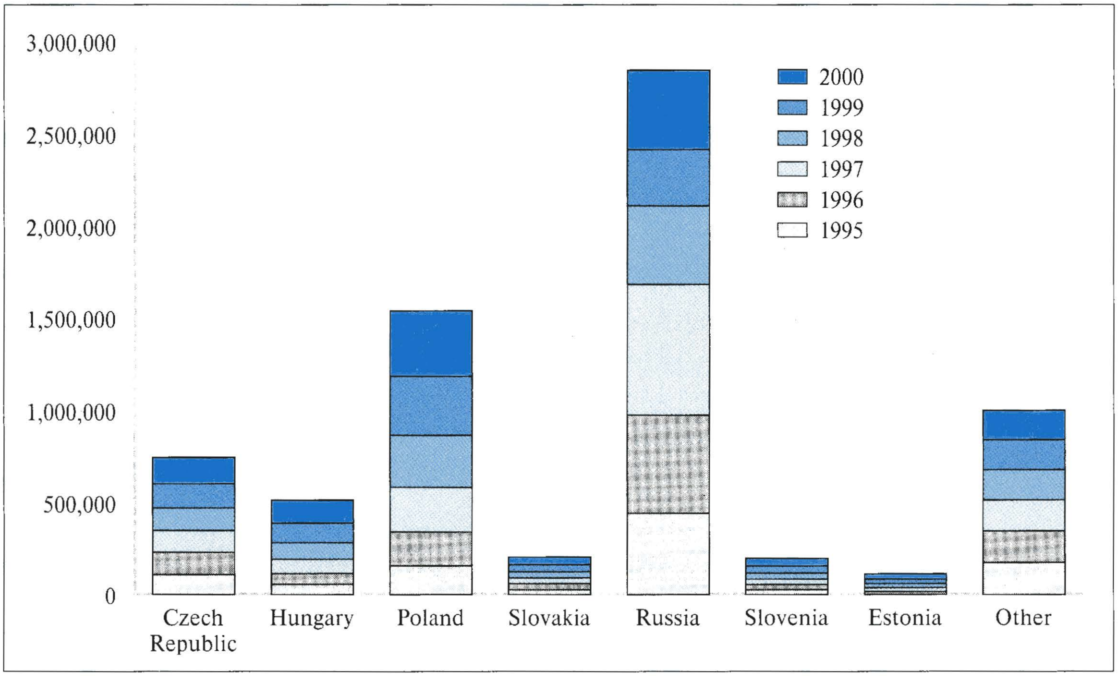
Despite rising sales, the personal computer markets of Central and Eastern Europe are relatively small. The total number of personal computers supplied in 1998 to the countries examined in this survey was similar to that of France which posted nearly 2.8 million unit sales in 1997. Market values are also considerably lower than in Western Europe, due in part to the predominant position played by low-cost local assemblers in the respective country markets. Moreover, the regional market remains extremely price sensitive in view of low per capita incomes.

The regional PC market is driven by demand in Poland and Russia. Sales to the two countries accounted for nearly 64% of the 5.1 million units shipped in the 1997-1998 period. While the Czech Republic has remained the largest PC market among the smaller countries of the region, shipments have stagnated over the past several years in the wake of economic and political problems. Similarly, the Slovakian market has shown little growth in the 1997-1998 period as demand has waned in key sectors such as government administration and banking/financial services. The Hungarian PC market has resumed the path of growth now that the country's economy has moved to recovery and expansion. Although small, the PC markets of Slovenia and Estonia have relatively high levels of penetration. Both continue to achieve strong growth.

Despite significant price competition from international brand vendors, local assemblers have retained their share of the regional PC market. In 1997, up to 67% of the PCs sold in Central and Eastern Europe were manufactured by local firms, while international brand vendors accounted for only 26.4% share. The actual share of locally assembled PCs even expanded in several country markets in the 1996-1998 period. Nevertheless, competition is becoming more intense. The advent of the < US$ 1,000 PC is already threatening the position of local firms which are beginning to encounter more severe cash-flow problems in the face of falling margins. Local OEMs also face other challenges such as the emergence of new channel models and sales through the World Wide Web. Several leading assemblers in the region have already left the market and others will surely follow over the next few years. Many more are consolidating and restructuring operations, while focusing activities on more profitable segments such as software implementation and services support.

This regional PC market will continue to grow strongly, with sales more than doubling through the year 2001. Personal computer shipments will be strongest in Poland and Russia, which are expected to consume more than 1.5 million units by the year 2000.

Figure 5
Overview of personal computer shipments in Central and Eastern Europe, 1995-2000



2.2.3. Systems and servers

Efforts are now under way through Central and Eastern Europe to integrate the large amounts of hardware shipped in the region over the last ten years. This factor and other developments such as the requirement to share resources, to network sites, to access the Internet, and to implement cross industry application solutions have generated notable local demand for computer systems and servers.

In 1998, the systems and server market for the countries examined in this survey reached ECU 775 million in revenue, which was up by less than 1% over the previous year, due to the contraction in the Russian market. Servers comprised 3.4% of the total regional ICT market for the year.

The major characteristics of the region's server market can be summarised as follows:

- It consists largely of low-end Intel-processor-based LAN servers priced at under ECU 20,000. PC servers represent the dominant multi-user platform. In 1998, they accounted for more than 92% of sales in the countries examined in this survey.
- A large increase in servers running Windows NT, a stagnation in shipments of Unix-based servers, and a significant decline in the number of new server installations running versions of NetWare or IntraNetWare. Windows NT now represents the leading server operating system platform in the region in unit terms.
- Unix continues to account for the highest percentage of regional server market value. Unix represents the leading platform in the midrange server segment.
- Reflecting the regional market's low-end focus, the computer systems (mainframes, high-end servers) segment has stagnated in most countries in terms of unit sales and

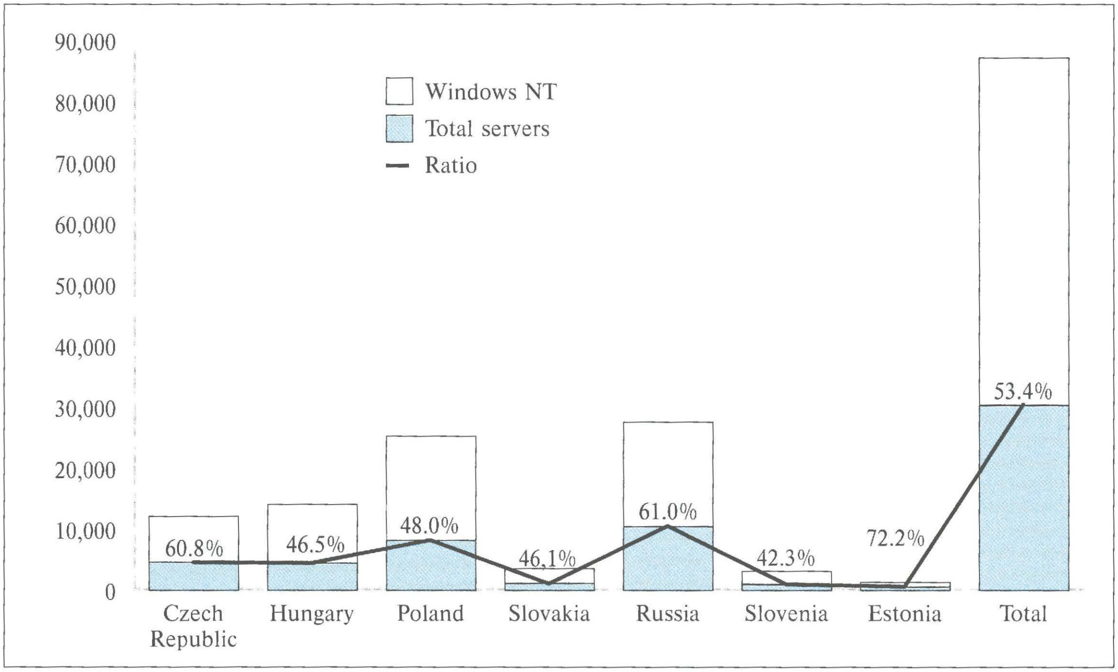


Figure 6
Overview of Windows NT penetration in Central and Eastern Europe, 1998

value due to reductions in funding for public IT projects (Czech Republic, Slovakia, Russia), problems in the banking sectors (Russia, Bulgaria, Czech Republic), limited demand for high-performance mainframes, and a decline in average system values for servers.

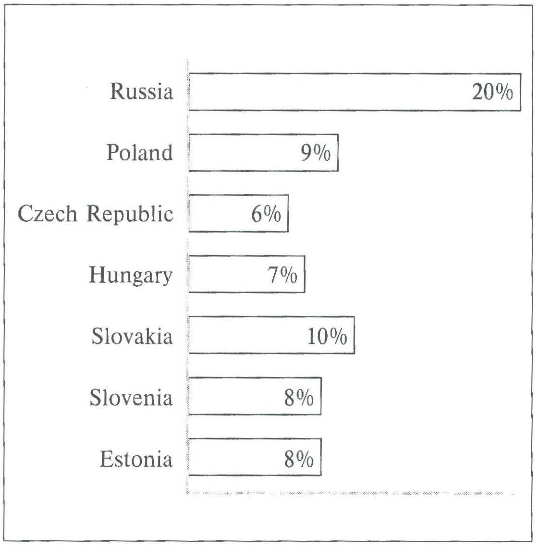
2.2.4. LAN and internetworking hardware technology

The LAN hardware market in Eastern Europe is reshaping business by allowing users to share resources, collaborate on projects, and modernise their computer systems towards Western European standards. Added networking functionality permits organisations in the region to reduce costs previously budgeted for software and peripherals, such as modems and printers. This regional adaptation of the LAN market paradigm is dependent on two primary contingencies, the first is the growth of the personal computer market and secondly the modernisation of the telecommunications infrastructure.

Countries that have sustained high growth in both of these areas, such as Hungary, now lead Central and Eastern Europe in terms of connectivity and workforce modernisation. Furthermore, this networking between PCs, workgroups, and businesses has encouraged steady growth in several related areas, such as the Internet, electronic commerce, and enterprise resource planning applications.

Spending on LAN hardware technology in Central and Eastern Europe reached ECU 450 million in 1998. The regional LAN hardware market saw a dramatic migration from Ethernet technology to faster technologies like Fast Ethernet and ATM last year and IDC anticipates this trend continuing well into the new millennium. Additionally, more intelligent LAN hardware products, such as switches, routers, and RAS, are expected to show double-digit compound annual growth rates over the next five years. Overall, this market is projected to grow by more than 6% through the year 2000, as the Russian market recovers.

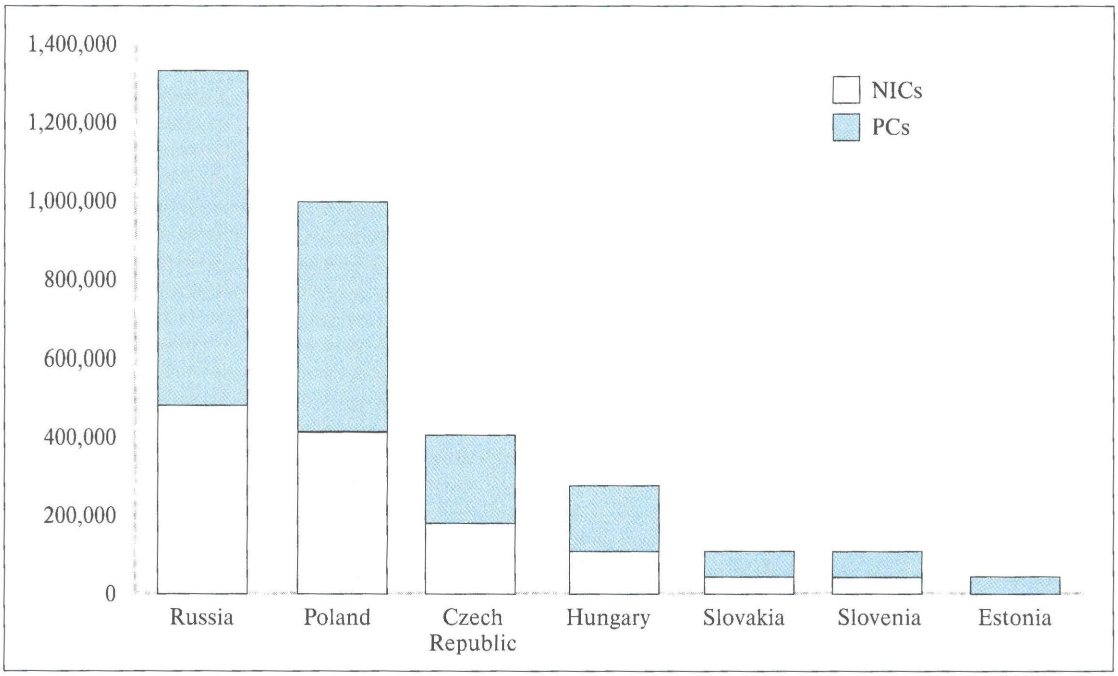
Figure 7
Compound annual growth rate for spending on LAN technology in Central and Eastern Europe, 1997-2000



Other major characteristics of the region's LAN hardware market include the following:

- Steady shipments of personal computers over the last several years have been matched by growing sales of network interface cards (NICs). Although shipments of NICs have been high, their installation ratio to PCs remains low, thus the overall connectivity of the market remains well below Western European standards of 85%.
- The modernisation of private networks continues as outdated cabling is replaced by newer unshielded twisted-pair (UTP), coaxial cable, and fibre lines. These allow businesses to install networks able to operate at greater speeds without bandwidth hindrances faced in most older buildings.

Figure 8
Network interface card to personal computer shipments comparison for Central and Eastern Europe, 1998



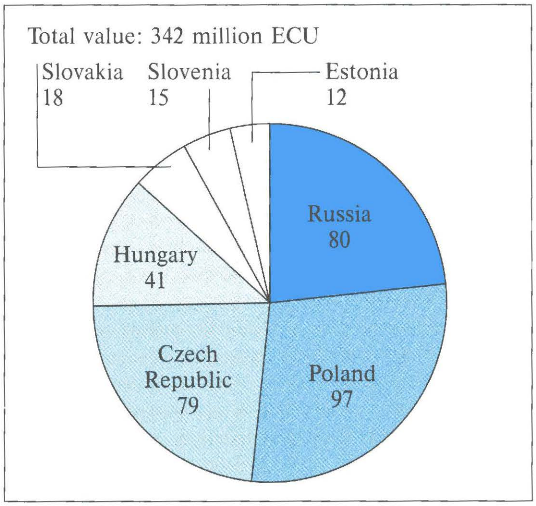


Figure 9
Overview of the value of LAN hardware shipments in Central and Eastern Europe, 1998, million ECU

	Shipments %	Installed base %
Russia	47	36
Poland	65	46
Czech Republic	65	53
Hungary	60	45
Slovakia	63	50
Slovenia	70	60
Estonia	58	47

Table 9
Percentage of personal computers connected to a Local Area Network in Central and Eastern Europe, 1997

- As shipments of interface cards rises throughout the region, the year on year ratio for installed base connectivity will increase. The PC to NIC ratio for 1997 exceeded 50% in all countries covered in this survey except Russia. Furthermore, installed base connectivity will continue to expand rapidly as growing international internetworking trends influence the market and trends in Internet commerce begin to emerge.
- The LAN products most often implemented by East Central European organisations include: network interface cards, hubs, switches, routers, and remote access servers. Each of these technologies offers advantages for increasing both connectivity and speed when implemented. Current purchasing trends are directly influenced by each corporation's budget and then by need. Thus companies, such as banks, may not purchase as many LAN products, but will instead gravitate towards high-end products that will ensure quality of service regarding business transactions and communication. Smaller companies that are modernising their computer networks, however, will be more likely have less of a preference for quality and instead focus on connecting all users to the corporate network to speed business processes.
- As LAN technologies are implemented in East Central Europe to handle voice, video, and data transactions managing bandwidth will become most important to IT departments. Hardware solutions, such as switches and routers, will be utilised to ensure certain amounts of data quality and speed to end-users. As prices decline for technologies investments by companies will drive the value of the LAN hardware market. These two factors will increase overall connectivity over the next five years towards those of Western European countries.
- Prominent LAN technologies in East Central Europe include Ethernet, Token Ring, ATM, and FDDI. Ethernet is the most common networking solution accounting for over 90% of LAN protocols. The lower cost of products and wide range of applications associated with this technology continue to encourage both large and small network installations. Additionally, as organisations develop Intranets and Extranets and offer more service via the Internet, Ethernet has proven to have the greatest return on investment. ATM (Asynchronous Transfer Mode) is expected to be implemented gradually throughout the region as telecommunications infrastructures are updated and band-

width requirements create a higher demand for this technology as a backbone solution.

- Factors inhibiting growth in the region's LAN hardware market include the lack of ICT funding, the poor state of telecommunications in many countries, particularly in rural areas, and the high costs associated with the maintenance and installation of interface cards, hubs, switches, and routers. High-end technologies, such as switches and routers, that combine hardware and software, often require experienced professionals to install and maintain their operation and high levels of performance.

2.2.5. Packaged software

As with worldwide trends, packaged software represents one of the fastest growing segments of the IT market in Central and Eastern Europe now that the region has entered a more advanced level of computerisation. Particularly strong growth is being seen in the market for basic operating systems, PC application software, integrated ERP applications and application tools for database development and management. The regional value of the packaged software market reached ECU 773 billion in 1998, which was up nearly 6% over the previous year, despite the crisis in Russia. Software comprised 3.5% of ICT expenditures in the seven countries examined in this survey.

The ratio of software sales to overall IT spending in most countries in the region is still low compared to Western Europe. The exceptions here include the Czech Republic, Hungary and Slovenia whose ICT markets are beginning to mirror the types of more mature structures common to the average EU country. Nonetheless, overall expenditures on packaged software are still low. Even Russia, by far the largest IT market in the region, spends far less on software products than countries such as Belgium, Finland or Austria.

Other major characteristics of the region's software market can be summarised as follows:

- Application solutions accounted for more than 61% of software spending in 1998, while systems infrastructure products and application tools comprised a further 39%. The applications segment will continue to be a major driver of software market development.
- Sales of business application software have experienced a period of unprecedented growth in the region, and demand is expected to be strong into the new millennium. The major market driver is a shift from in-house solutions to standard software application packages developed by multinational vendors. Organisations have begun implementing applications that support integrated finance and planning tools for enterprise-wide integration of manufacturing, distribution and human resources. Although international vendors have gained a large share of the regional market, local vendors remain competitive, particularly in the SME segment, with less expensive localised application solutions and software tools.
- Adoption rates for integrated ERP applications continue to grow strongly in the region. The inclusion of medium-sized companies in the ERP vendors' target groups has now expanded the scope of business. This dynamic will also carry over into the small business segment as software vendors introduce new products for a Windows NT environment.
- While desktop application and OS sales are up, most growth in the software sector is derived from large-scale projects in banking/financial services, government administration, telecommunications and industry/manufacturing. Nonetheless, the growing complexity of applications and solutions is driving demand for support in other vertical market segments, and among small and medium-sized companies.

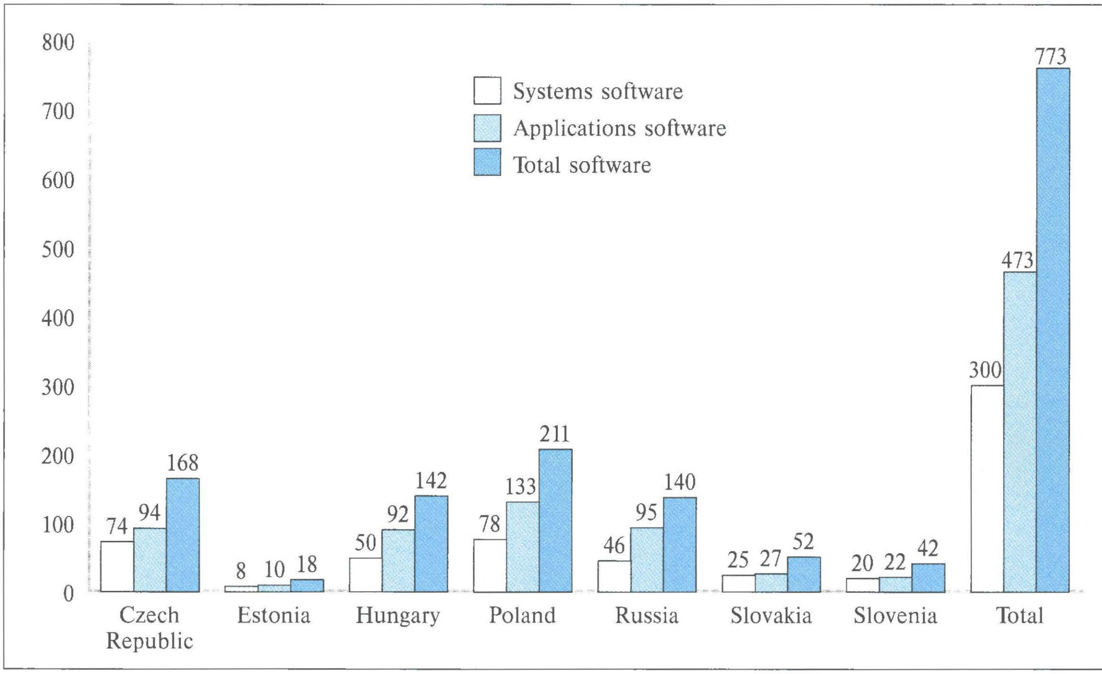


Figure 10
Overview of the packaged software market in Central and Eastern Europe by category, 1998, million ECU

- While local companies have been orienting their efforts toward the SME segment over the last several years, international vendors of client-server and cross industry applications are just beginning to focus on small and medium-sized companies. The major strengths of local software developers are lower prices for both licences and implementation, complete localisation and customisation capabilities. A number of companies have also seen success by focusing their activities on niche segments, such as tools, for both local consumption and export. The major competitive challenge for local firms is to raise enough capital to continue investment in research and development to improve applications.
- Although legal sales of desktop operating systems and applications have risen steadily, software piracy remains a major inhibitor of growth. According the Business Software Alliance and the Software Publishers Association, Central and Eastern Europe continues to be the region with the highest piracy rate. Nearly eight out of ten applications were pirated in 1997. Losses for the whole region amounted to ECU 442 million for the year. Nonetheless, notable progress has been made due partly to the implementation of various anti-piracy campaigns (e.g. new copyright laws, regulations and legalisation campaigns), along with the establishment of special task forces to oversee enforcement. Programmes supporting software sales with price discounts or pre-installed software options have become very popular in the region. Piracy rates have also fallen due to the growing complexity of applications and requirements of support.
- Software is expected to account for a larger share of the overall regional IT market through the year 2000.

Table 10
Overview of software piracy rates in Central and Eastern Europe, 1994-1997

Piracy study results	Piracy rates				Retailed revenue, pirated ('1000) in ECU			
Country	1994 %	1995 %	1996 %	1997 %	1994	1995	1996	1997
CIS – less Russia	95	94	95	92	24,793	29,175	38,972	34,881
Czech Republic	66	62	53	52	76,535	44,202	54,525	40,944
Hungary	76	73	69	58	80,278	43,397	33,865	20,079
Poland	77	75	71	61	164,001	118,396	133,297	84,787
Russia	95	94	91	89	406,705	237,188	301,967	198,397
Slovakia	66	62	56	58	18,657	10,776	11,073	13,407
Slovenia	96	96	91	76	15,033	15,893	6,827	7,246

2.2.6. IT services

In 1998, the IT services market in Central and Eastern Europe generated ECU 1.56 billion in revenue, representing close to 7% of IT spending in the region. Implementation services accounted for the largest share of the market with 47%, followed by support services and IT consulting. IDC expects IT services to represent the most dynamic ICT market segment over the next several years in terms of growth potential.

The Czech Republic oversees the largest IT services market in the region, followed by Russia, Poland and Hungary. While services spending has grown rapidly in all markets of the region, expenditures pale in comparison with relatively small IT markets in Western Europe such as Austria, Finland and Switzerland.

Factors driving the demand for IT services in Central and Eastern Europe include the pace of technological change, the Year 2000 problem, the growing popularity of packaged application solutions, Internet/Intranet growth, the limited skill base of user sites and the trend toward networking and connectivity. In view of the growing sophistication of technology, external providers (IT and other) are increasingly viewed as the best solution to implement the required changes, despite the relatively low wage rates of local employees.

Several factors inhibiting the development of the region's IT services market include the traditional preference for in-house implementation and support, price sensitivity and concern over fees, user suspicion of service providers particularly consultants, the poor state of the region's telecommunications infrastructure, and the absence of real project management skills among many local providers.

The characteristics of the region's services market by major segment can be summarised as follows:

- Central and Eastern Europe's transition to a market economy has forced firms in the region to explore opportunities for improving performance and business processes to enhance efficiency, competitiveness and profitability. Moreover, outside firms investing in the region are increasingly requiring local knowledge support in establishing and support operations. These developments have facilitated a growing demand in the region for business and management consulting services, including consulting support for the design and implementation of MIS systems and newer enterprise-wide applications. While much of the IT consulting currently being undertaken in the region is related to

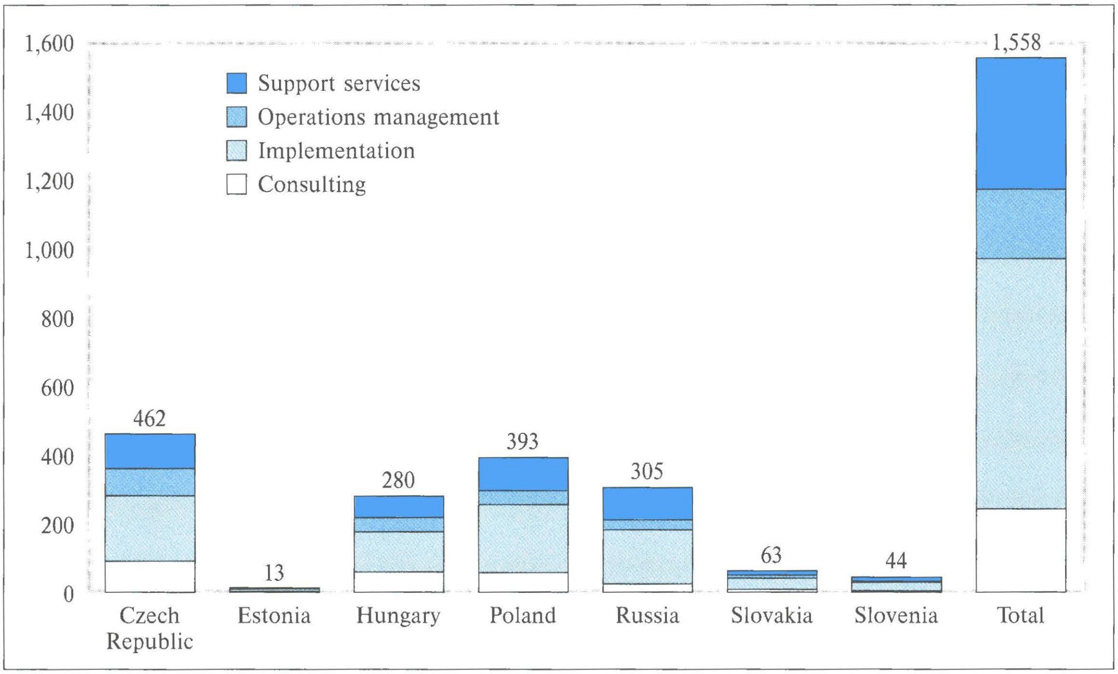


Figure 11
Overview of the information technology services market in Central and Eastern Europe, 1998, million ECU

business process-oriented management service activities, incorporating some IT components, technology and product consulting are still more common, due to the attitudes and limited requirements among local users, and concern over the price of such support. The exceptions here include banks, financial services institutions, some companies in the manufacturing sector, and the local organisations of international investors.

- At its current state of development, the IT services market in the region largely revolves around implementation activities, in particular hardware and software installation. The effort of local firms to restructure and improve the efficiency of their operations through the introduction of contemporary IT hardware, software and networking has driven the demand for information technology, and with them, the requirements for application development, hardware and software installation, systems/network implementation and network integration.

Once focused on hardware, a growing share of services revenue in the region now stems from networking installation and packaged software implementation and support. In particular, the growing popularity of integrated client-server ERP is driving spending on services, due to the difficulty of implementing such software. Major technology vendors, local systems integrators and consulting firms (Big Six) have all added ERP consulting and implementation expertise to their IT services staffs, while contracting local VARs for application development, maintenance and integration support.

- The operations management segment, comprising activities such as IS outsourcing and IT training represents the smallest IT services category in the region, albeit the fastest growing. The IS outsourcing market in Central and Eastern Europe was traditionally confined to processing services conducted by large state-owned IT dataprocessing centers such as the SZÜV network in Hungary, the PVT in the Czech Republic, or the ZETOs in Poland. Despite the major economic and political changes introduced after 1989, dataprocessing comprising such activities as pay-roll has continued to be the chief outsourcing activity in the region. The first signs of a slowly emerging local market for outsourcing first appeared in the 1996-1997 period, when larger user organisations, particular in the banking/financial services and manufacturing sectors, began showing an interest in having external organizations provide support for both IS operations and business processes. Moreover, a number of IT vendors also took steps to expand their local IT services product portfolios to include the range of operational services. Demand for outsourcing is being driven by the increasing need for external network management, new solutions migration and growing complexity of IT operations. Hungary has the most dynamic IS outsourcing market in the region.

- Several factors limiting the demand for outsourcing include concerns over employment, limited funding for this type of support, sunk costs in large data facilities, delays in the privatisation of key sectors, and fears surrounding data security.
- One services market segment which has drawn the attention of local and international IT vendors alike is IT education and training. Almost non-existent a few years ago with the exception of programmes sponsored by state-owned IT organisations and government ministries, the market for education services is now prospering in the face of strong demand for product support training. Large investments in hardware and software demand comparable investments in "peopleware" to exploit the technology. While considerable IT training is still conducted internally, local IT managers are increasingly turning to outside resources to meet the knowledge and user requirements of more sophisticated hardware and software solutions.
- The fast pace of technological change, the increasing integration of multiple platforms and the growing complexity of solutions are driving the demand for support services. While support was traditionally focused on hardware, growing sales of packaged application solutions have led to greater demand for basic software support. Nonetheless, the region's low wages still facilitate a preference for in-house support, rather than relying upon an external provider.
- Competition is growing in Central and Eastern Europe's services market as a number of international vendors initiate operations in the region and local firms revise their activity to focus on this evolving market opportunity. Nonetheless, local firms have emerged to become the chief actors in this market segment, functioning as systems integrators, value-added resellers, support providers, software developers and training centres. A number of major international hardware and software vendors have already teamed up with local companies to offer consulting, implementation and maintenance support. Several major mergers and acquisitions have also taken place, particularly in the Czech Republic, Hungary and Poland.

2.2.7. Evolving Internet market

The IT market is being fundamentally redefined by the establishment of a pervasive electronic marketplace that will connect over 1 billion people worldwide by 2005. Growing steadily in penetration and intensity, the Internet is quickly becoming a an important phenomenon in Western Europe. The region's Web population is expanding rapidly, and the Internet is surpassing the PC as the engine of growth for the information technology marketplace. This development has also carried over to

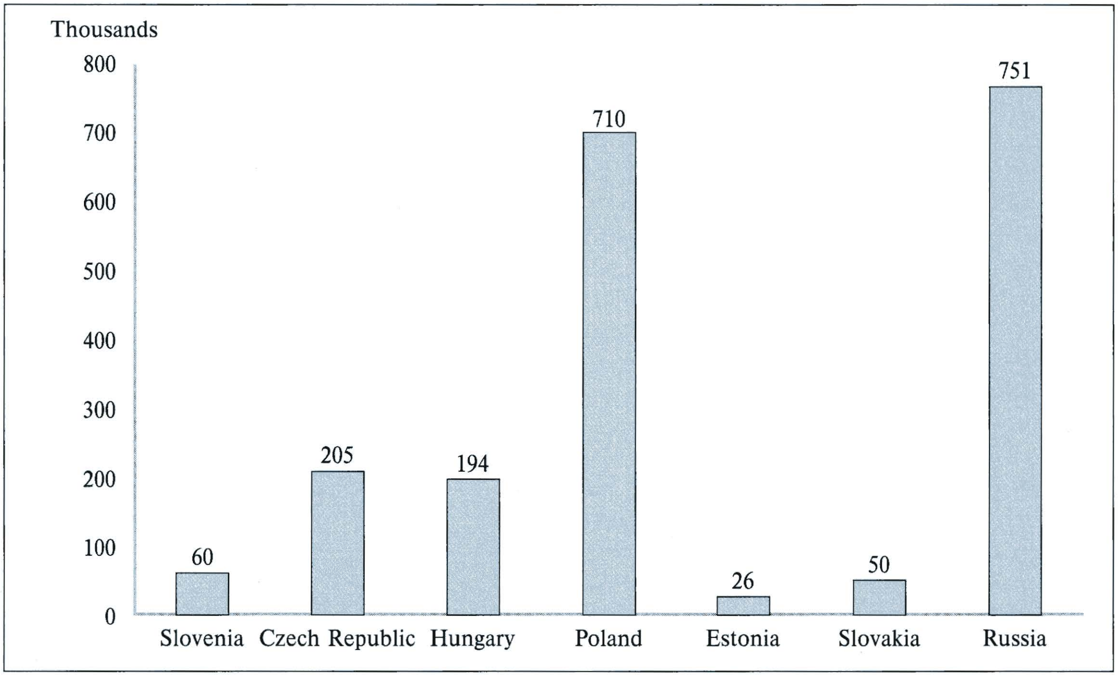


Figure 12
Number of Internet users in Central and Eastern Europe, 1998

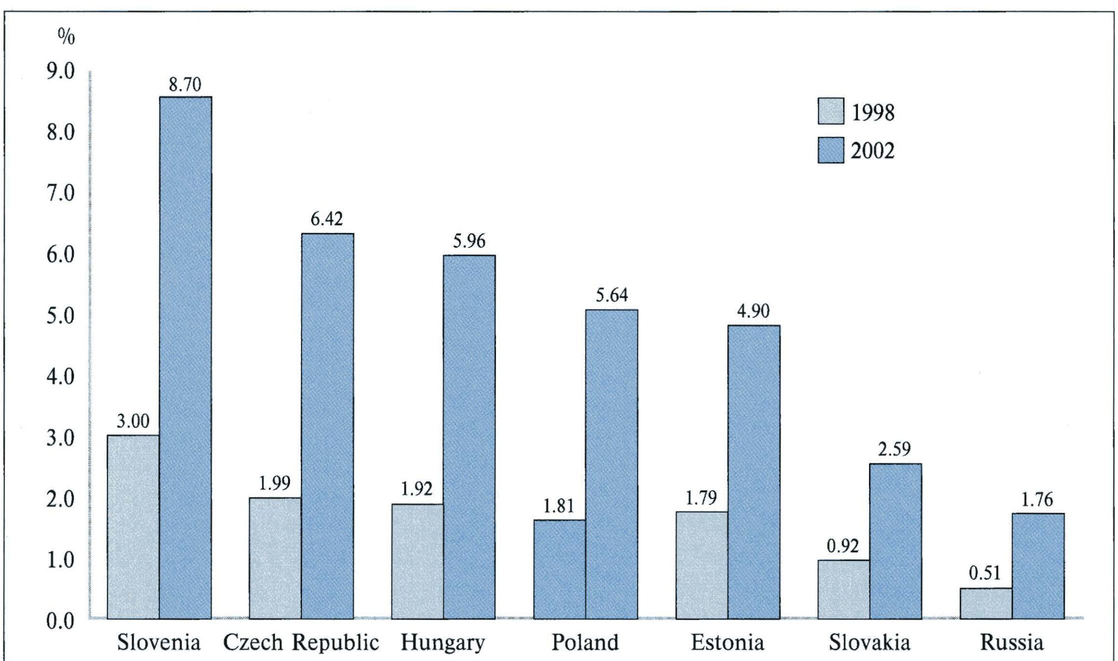


Figure 13
Internet users as a percentage of population in Central and Eastern Europe, 1998-2002

Figure 14
Internet host count in Central and Eastern Europe, June 1998

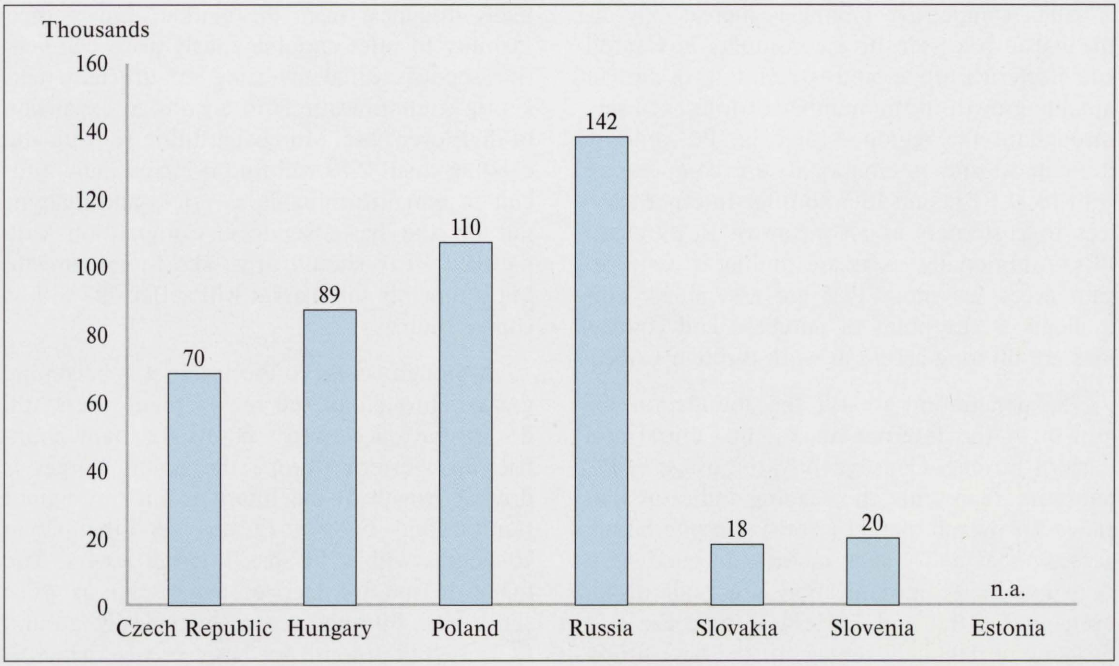
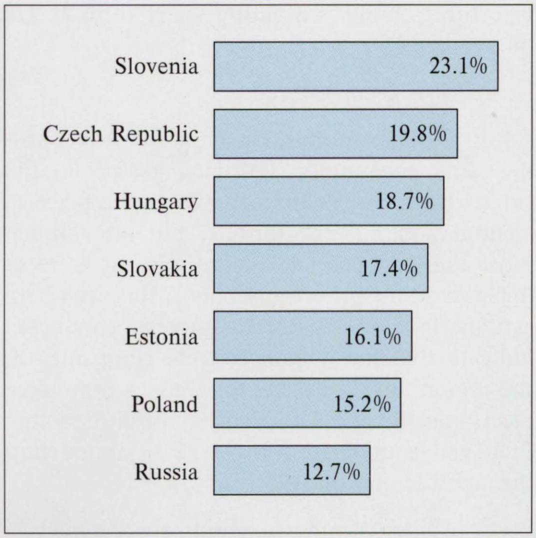


Figure 15
Percent of personal computers connected to the Internet in Central and Eastern Europe, 1997



Central and Eastern Europe, albeit on a much more limited scale. While the number of new ISPs and users in the region has mushroomed, a variety of infrastructure and economic factors are undermining demand for this technology.

The growing proliferation of the Internet in Central Eastern Europe is being driven by reduced cost to connect and ease of obtaining a connection. As a result of the boom of the Internet worldwide, decreased cost as a result of economies of scale have trickled down to developing markets for basic connection hardware such as modems, NICs, and PCs and more complex goods which form the backbone of the Internet, such as switches, routers, and RAS. Ultimately, lower prices for Internet hardware and basic telephony, combined with the emergence of more competitive pricing among local PTTs and new providers in the wake of telecommunications liberalisation, will make the Internet a more affordable means of communication for users in the region.

Such competitive pricing is increasingly attractive to price-sensitive consumers in Central and Eastern Europe, and is resulting in part in notable growth in the number of Internet users throughout the region. Moreover, PC vendors (both local and international) are co-operating with local PTTs and ISPs to offer Internet services to customers as an incentive to purchase PCs. Additionally, users are finding it easier to gain access as more PCs are assembled with modems at the point of purchase and companies are offering access at work through LANs.

PC penetration is still the foundation for growth in the Internet market in Central and Eastern Europe. Consequently, the usage of PC hardware represents the leading indicator and gauge for overall market growth. Despite falling access prices and a slow increase in bandwidth as regional telecommunications are modernised, users in Central and Eastern Europe are still focusing on taking advantage of the base utility of their PCs.

Nonetheless, one of the greatest limitations for Internet growth in the region is the low installed base of PCs, despite the notable growth in this market segment seen over the last several years.

Other significant hindrances to the development of Internet market in Central and Eastern Europe include the strong position of local PTTs in the markets for telephony and datacommunications, a limited home market segment, underdeveloped telecommunications infrastructure, and extreme price sensitivity among regional users. National PTTs have recognised that ISP and datacommunications transmission services have become strategic to their businesses. As a result, PTTs are becoming ISPs with an overwhelming advantage over competitors due to the availability of more investment capital and unrivaled infrastructure. As competition between the larger ISPs and the PTTs begins to escalate, smaller ISPs will most likely disappear from the market, due to their inability to offer simultaneously price competitive services while investing in sufficient marketing communications to ensure an expansion of their user base. Moreover, future start-up and existing small ISPs will find it increasingly difficult to remain profitable as prices and margins fall on the basic services. Competition with national PTTs should drive short-term growth, but ultimately the market will suffer due to less competition.

Although access to the Internet is becoming greater throughout the region many users still do not have access to a phone. In many countries in Western Europe the home market is driving growth of the Internet, but throughout Central and Eastern Europe less than 1 in 10 homes with a PC has Internet access. The major reason for lack of penetration is price sensitivity. Internet access is typically around ECU 15.8 per month for basic service, which is prohibitive for the typical worker of the region who brings home a monthly salary of ECU 236 on average.

2.2.7.1. E-commerce

In Western Europe E-commerce from business and consumers is driving growth in the Internet market. E-commerce is taking place in Central and Eastern Europe, but on a much more limited scale and typically in the form of business-to-business transactions. But even here activity is limited. Recent surveys conducted indicate that more than 65% of companies in the region have no plans to conduct commerce electronically, and less than 9% indicated that they had conducted some type of transaction through the end of 1998.

Consumer commerce is unlikely to evolve in the region due to the limited penetration and usage of electronic banking and the low number of inhabitants with credit cards. Currently less

Table 11
Average monthly wages in Central and Eastern Europe by country, 1997, ECU

Czech Republic	Hungary	Poland	Slovakia	Slovenia	Russia	Estonia
262	245	278	225	710	143	205

Source: Business Central Europe, 1998

than 3% of all inhabitants in Central and Eastern Europe have credit cards. Despite the fact that the number of card users is growing rapidly, it will take some time for banks and credit lenders to set-up an infrastructure which will support an extensive credit market in the next few years. The poor state of the region's telecommunications infrastructure also presents a barrier for on-line transactions.

2.2.8. Telecommunications

Each Central and Eastern European country has taken its own unique approach to developing its telecommunications infrastructure to meet contemporary standards. Most countries in the region have attracted foreign investment and expertise by promising exclusive monopoly rights into the next century for key areas of the communications business. The enticement of exclusive monopoly rights has led to the centralised, coordinated development of important and profitable national network backbones and international connectivity, as well as having increased ordinary consumers' access to the network.

In areas not covered by monopoly rights, which on the whole are limited to basic fixed telephony and national and international networks, competition between network operators and service providers has flourished. The explosion of mobile communications across the region as well as growth in Internet access owe much to this competitive context.

Despite significant progress in the modernisation process the region of Central and Eastern Europe still remains significantly behind Western Europe. The two most critical problems are low teledensity (the number of telephone lines per 100 inhabitants) and meeting demand for data and information services. Western telecommunication companies are anxious to enter or partner in these markets in order to develop infrastructure for higher teledensity rates and expand services like call centres, teleconferencing, collaborative working, Internet access, and other telecom-related services. The region has seen a marked difference between countries which involved strategic investors early on in their transition to a competitive telecommunications industry. There has been a clear correlation between the amount of outside investment and development of the telecommunications environment.

2.2.8.1. State of the telecommunications infrastructure

Telecommunications markets are evolving differently in each country, due primarily to different paradigms on how best to privatise their market. The Czech Republic and Hungary privatised early and are modernising their current infrastructure and are moving to meet EU integration standards. Estonia, Poland, Russia and Slovenia are developing their infrastructure and expanding their service portfolio in order to increase the value of their state run telecommunications organisations before they are privatised. Additionally, Russian and Polish governments are under pressure to privatise in order to generate revenue for the state. Slovakia, although not slated to privatize its PTT or liberalize its market until 2003, is re-evaluating an earlier privatisation date in the wake of the September 1998 election.

Outside investment is beginning to widen the stratification among Central and Eastern Europe telecommunications markets. In the early nineties all the markets were suffering from long waiting lists for phone lines, low level of line digitisation, poor line quality, and low customer satisfaction levels. In markets which foreign investors were able to enter early such as the Czech Republic, Estonia, and Slovenia, many obstacles have been quickly overcome. In the Czech Republic and Hungary waiting lists for phone lines have decreased to a matter of weeks. In Poland, the average customer waiting period for phone installation is still up to 34 months.

While growth of fixed telephone lines installed has been notable throughout the region over the last several years, figures for individual countries still fall far short of the Western European average of 50%. Slovenia and Estonia field the highest penetration rates, followed closely by the Czech Republic and Hungary. Despite notable investment by the state PTT, Poland still has the lowest rate among countries examined in this survey.

Outside investors are pushing their PTT partners in the region to increase phone quality and teledensity so they can maximise market share and penetration before markets are fully liberalised. While still far short of the Western European average of 90%, line digitisation has nearly doubled in countries like the Czech Republic and Hungary since privatisation. Although Estonia is not the most digitised country it compensates with the largest number of mobile users, more than 10% of the total population. Consistent with lower penetration rates, Russia and Poland have the lowest network digitisation rates.

The most limiting factor for future growth of the telecommunications industries in Central and East European countries will be charges. The cost of international calls are higher in most East European countries than in most West European markets, because investors want to generate return on their substantial investments in modernising the antiquated telecommunications infrastructure before their market opens to competition. This artificially high-pricing has given birth to a plethora of call back services throughout the region.

One of the highest growth areas for telecommunications in Central and Eastern Europe is the mobile sector, for both services and equipment. Market liberalisation combined with increased requirements for mobility, slow fixed-line growth rates and the licensing of several competitors in each major market, with the exception Slovenia, have helped make mobile telecommunications a reasonable alternative for many users in the region. At the end of 1997, Estonia retained the highest mobile penetration rate in the region with 10%, followed by Hungary (7%), Slovenia (6%) and the Czech Republic (6%).

The telecommunications market in Central and Eastern Europe will only achieve a 3.4% growth rate in 1999, on the basis of declines in revenue from public telecommunications equipment, private telecommunications equipment, and telecommunications services. While most countries will see double-digit growth in the demand for telecommunications, the downturn in the Russian ICT market will impact negatively on regional sales.

2.2.8.2. Alternative infrastructure

Long waits for land lines and expensive pricing due to high tariffs is fostering growth in the demand for alternative communication infrastructures in Central and Eastern Europe. Aside from current concerns of modernisation and creating a competitive environment, the PTTs in the region will compete with wireless local loops, IP telephony, and cable TV networks.

Wireless local loop

Wireless local loop is rapidly expanding throughout the region because it is a cost-effective way of providing local communications,

Table 12
Overview of privatisation plans for telecommunications in Central and Eastern Europe

	Company	Stake	Investors	Date	Liberal-isation	Number of subscribers	Tele-density	Fixed operator	NMT Mobile operator(s)	GSM Mobile operator(s)	GSM launch
Czech Republic	SPT	27%	Swisscom Telia	1995	2000	3.27	31.6%	Swisscom KPN	US West Bell Atlantic	EuroTel Prague Radiomobil/ Paegas	1996 1996
Estonia	Estonian Telecom	49%		Fall 1998	2000	0.43	32.0%	Telia Sonera	Telia Sonera	Eesti Mobiiltelefon Radiolinja Eesti/ Eurofon Ritabell	1995 1995 1997
Hungary	MATÁV	60%	Deutsche Telekom Ameritech	Nov. 1993	2002	2.92	28.0%	Deutsche Telekom Ameri-tech	US West	Westel Pannon	1994 1994
Poland	TPSA	20-25%		Nov. 1998	1999	7.06	17.9%	state-owned	France Telecom	France Télécom Polkomtel Polska Telefonia Cyfrowa	1998* 1996 1996
Russia	Svyazinvest	25%		Oct. 1998	TBA	35.07	24.0%	state-owned	state-owned	Vipelcom Mobile Telesystems (MTS) North West GSM	1997 1994 1994
Slovakia	Slovak Telecom	TBA		Jan. 2003	2003	1.38	25.5%	state-owned		France Télécom Eurotel Bratislava/ US West Bell Atlantic	1997 1997
Slovenia	Telekom Slovenia	TBA		Jan. 2001	2001	0.88	35.8%	state-owned	state-owned	state-owned	1996

* DCS Licence

and it is attractive in areas where phone line waiting lists are long. The penetration of this technology is so successful in Central and Eastern Europe that over half of the worldwide installed base of such equipment is in the region.

IP telephony

IP telephony has not really established itself in Central and Eastern Europe because most PTTs are barring the new infrastructure until market liberalisation. Several attempts to launch IP telephony have been furiously resisted by PTTs due to the potential loss of revenue. In the Czech Republic, for example, the mobile provider Ceske telekomunikace introduced an IP telephony service in 1998 which was quickly terminated by the government regulator with vehement support of the local PTT, SPT Telecom. The clear benefit of voice over IP is that it provides economical international communications, but most PTTs in the region have up to now not been able to evaluate what the real risk is with this technology. Once liberalisation occurs at the turn of the century, markets will see many entrants competing and providing voice over IP services. IP telephony still has

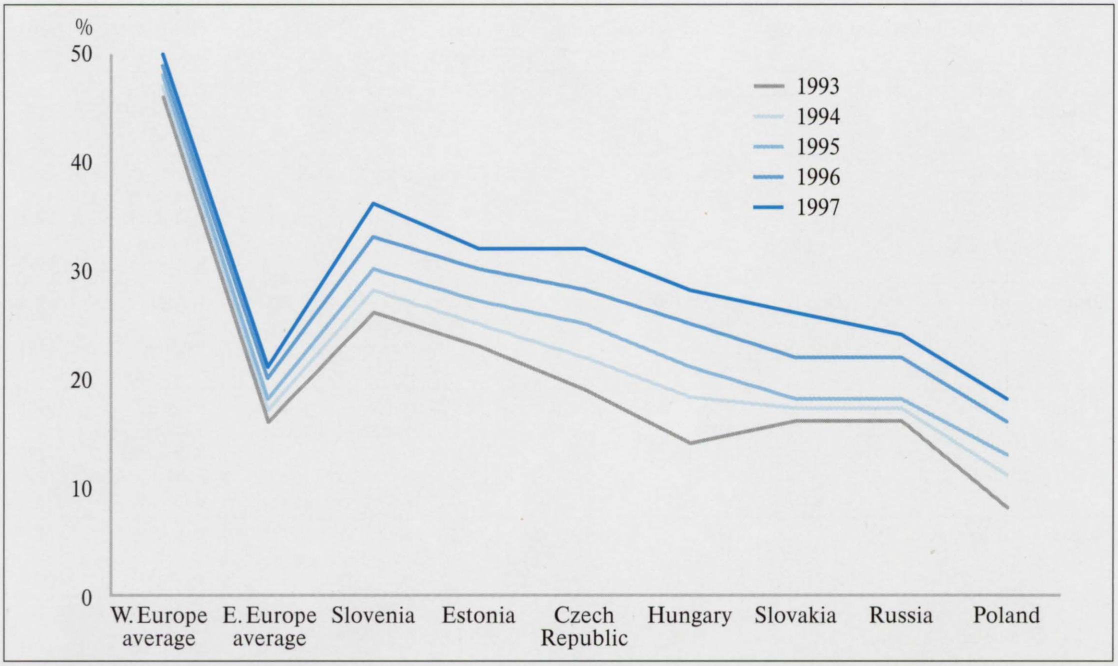


Figure 16
Growth in telephone density in Central and Eastern Europe, 1993-1997

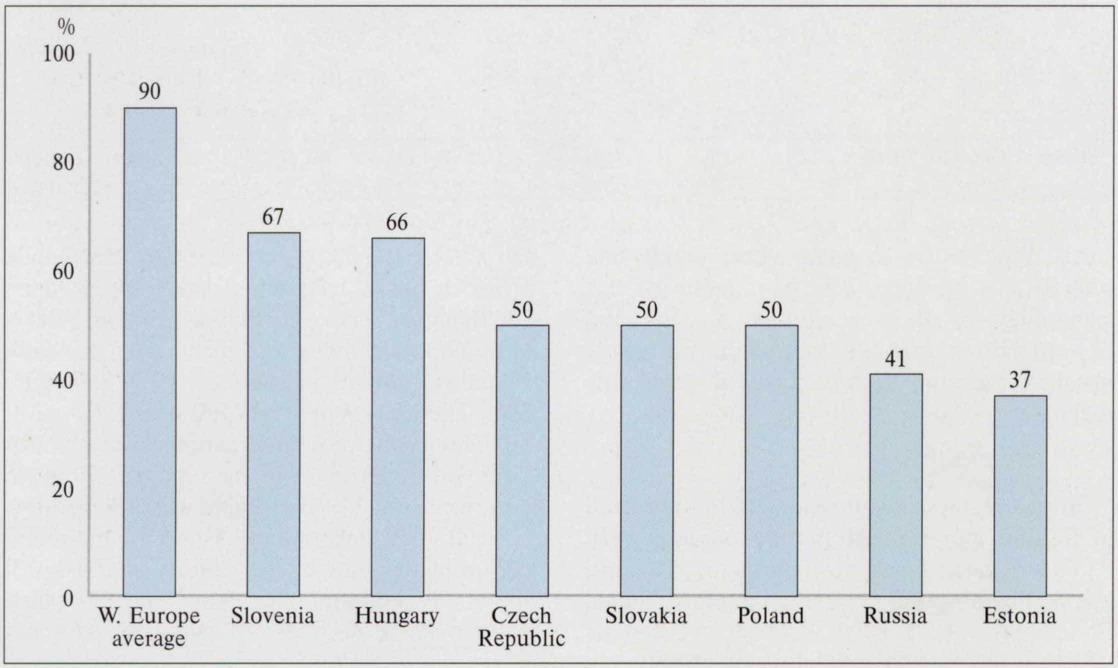
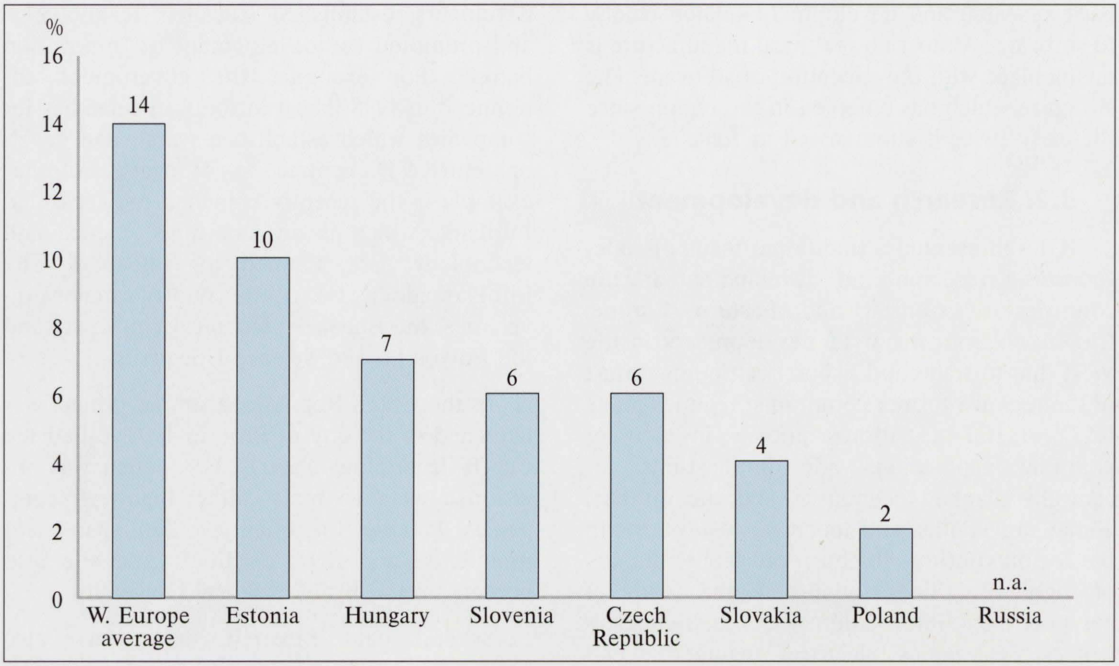


Figure 17
Level of network digitalisation in Central and Eastern Europe, end of 1997

Figure 18
Penetration of cellular telephones in Central and Eastern Europe, end of 1997



technical challenges which may curb growth such as Quality of Service (poor sound quality), interoperability and standards, and scalability and redundancy.

Cable TV networks

Nearly 30% of all homes in Central and Eastern Europe have some type of cable television connection. Nonetheless, most of the existing installations are dilapidated and have only limited bandwidth. Cable providers in the region are now examining ways to upgrade current connections to deliver local voice and data services. As with IP Telephony, cable TV providers will have to obtain permission from local regulators to be able to compete directly with their national PTT to provide voice service. Plans are already underway in several countries in view of eventual liberalisation of markets in accordance with EU membership.

3. ICT production and trade

3.1. Structure of ICT production and trade in Eastern Europe

The region of Central and Eastern Europe traditionally fielded a notable production base of original development and manufacture for IT. Much of it, however, was wholly obsolete by international IT industry standards. Consequently, the onset of outside competition with the region's opening in 1990 fundamentally altered the structure of ICT trade and production in all countries. The activities of the local IT industry are now largely confined to the distribution and resale of imported products manufactured in the West and the Far East, basic assembly and configuration for specific high-volume technologies (based on imported components), software development and sales, installation and implementation support for most ICT, basic maintenance and support, and basic research and development related chiefly to software. Almost no real local manufacture is taking place with the exception of software. The structure which has emerged in the region since the early 1990s is summarised in *Table 13*.

3.2. Research and development

ICT represented a traditional focus of state-sponsored research and development in the countries of Central and Eastern Europe. Closed off from major IT developments in the West due to trade and export restrictions, most of the region's former communist regimes made R&D of ICT a national priority in view of potential applications and implications for centrally planned economics and the military. Today, universities and technical institutions in the region continue to churn out large numbers of highly qualified students in the fields of computer and information sciences, radioelectronics, cybernetics, electrical engineering and mathematics.

The research and development community in Central and Eastern Europe has been hit hard by the region's transition to a market economy. With state funding on R&D being curtailed sharply in almost all countries, research activities have suffered from ongoing "brain drain" as many of the region's leading scientists and researchers take advantage of the higher salaries and better working conditions offered by Western companies. In an effort to retain local R&D capabilities, several governments have sought to transfer such expenditures to the private sector, albeit with varying levels of success.

While public spending on R&D has declined in Hungary, the government has made notable efforts to foster business spending in this area with the support of the State Office for Technical Development (OMFB). Employing various fiscal and monetary tools, it has introduced incentives such as tax rebates for local software developers, established so-called Technoparks, and promoted the development of "innovation banks". For example, the government announced in 1998 that it introduced subsidies for companies which establish research and development/R&D centres in Hungary. Another example is the recently launched project called InfoPark, which is an ambitious science and technology park planned for Budapest. The InfoPark adjoins two of the country's major universities, the Budapest Technical University and the Eotvos Lorand Science University.

In the Czech Republic, a similar project was launched in the city of Brno in 1992, called the Czech Technology Park (CTP), which was envisioned as a centre to draw high-tech companies looking for quality office space and production and R&D facilities. The site also borders on the Brno Technical University.

Several major research centers have also been established in Poland to transfer technology and expertise to local industry, including the Wroclaw University of Technology. It contains various labs such as the Wroclaw Technology Transfer Center (WTTC) and the Wroclaw Network Supercomputer Center (WCSS).

Significant support for research and development in Central and Eastern Europe has also been forthcoming from the European Union on the basis of several Framework Programmes launched successively in the 1990s. An extensive array of research and development programmes have been made available to organisations in the region including VLSI training, TACIS initiatives, TEMPUS, HCM, CRIT and various workshops. Many of these provide fellowships for local researchers and fund joint research projects, usually containing some ICT component. Various institutions have also been invited to participate in such high profile programmes like ESATT and ESPRIT.

Table 13
Overview of the structure of ICT production and trade in Central and Eastern Europe

Technology	Local industry role
Personal computers	Assembly/configuration Distribution & resale Installation and maintenance
Telecommunications	Assembly/configuration Distribution & resale Installation and maintenance Research & development
Peripherals	Limited assembly Distribution & resale Installation and maintenance
Software	Development & manufacture, export Customization & localization Offshore programming Research & development Distribution & resale Body shopping
Servers	Distribution & resale Research & development (supercomputing) Installation and maintenance
Services	Full provision

The availability of pools of highly educated researchers, combined with official incentives and lower costs and wages have influenced a number of multinational corporations to shift some of their research and development activities to Central and Eastern Europe. Hungary has attracted the most interest in the ICT area, including investments by Nokia Telecommunications which established an R&D center in Budaörs for the development of software for GSM switching technology, GSM networks, mobile Internet services and object-oriented applications. The center's 100 employee staff is eventually to be expanded from 500 to 2,000 employees. Other firms setting up R&D facilities in the country include Ericsson, IBM and Motorola (the latter with the Hungarian Academy of Sciences).

With its vast number of highly qualified research and institutions, Russia has also received considerable attention from ICT companies. Some of the most high profile ventures have been established by Sun Microsystems which has co-operated with the supercomputing group of Boris Babyan in Moscow, and the data encryption specialists Elvis+. It also funded the porting of several locally developed applications to Unix. Other notable examples include Corning which retains a laboratory in St Petersburg for fibre optic cabling, and Samsung which established a multimedia lab in Moscow in 1997.

3.3. Overview of major ICT production and manufacturing investments

The region of Central and Eastern Europe has seen a number of investments in ICT production over the last several years. The extent and content vary considerably according to country, reflecting the level of available local expertise, incentives and facilities. Nonetheless, most funding has gone to upgrading and utilising local plant facilities for basic assembly of components into finished products, particularly for the area of telecommunications. Another important area is software, be it custom software development, specific design and tailoring activities on packaged software developed abroad, localisation activities, or simple body shopping.

Investment in ICT in Central and Eastern Europe is being driven by the following factors: (1) modernisation of telecommunications infrastructures in which governments are requiring local content in component manufacture, (2) access to lower cost structures for basic assembly of IT components and peripherals, (3) access to highly qualified and skilled software programmers at lower cost rates, and (4) the availability of a pool of highly skilled scientists and researchers for R&D.

Country	Company	Product	Activity
Czech Republic	Motorola	Electrical components	Assembly, R&D
	IBM	Pcs	Assembly
	FIC	Pcs	Assembly
	Lexmark	Printer cartridges	Assembly
	ALPS Electric	Keyboards	Assembly
	AT&T	Telecommunications	Assembly
	Siemens	Telecommunications	Assembly
	Marconi	Telecommunications	Assembly
Hungary	Siemens	Telecommunications	Assembly
	IBM	Storage devices	Assembly
	Philips	Monitors, CD-ROMs, other	Assembly
	Punch International	IT components	Assembly
	General Electric	Components	Assembly
	Nokia Telecommunications	GSM technology, software	R&D
	Nokia Monitor Ltd.	Monitors	Assembly
	Ericsson	Telecommunications	R&D
Poland	Olicom	LAN technology	R&D
	Motorola	Semiconductors, software	R&D
	Seikosha	Peripherals	Assembly
	Fujitsu	Notebooks	Assembly
Russia	Sun Microsystems	Computer systems, software	R&D
	Samsung	Multimedia	R&D
	Siemens	Telecommunications	Assembly
	Alcatel	Telecommunications	Assembly
	Lucent Technologies	Telecommunications	Assembly
	Xerox	Photocopiers	Assembly
	SAP	Software	Development & Testing
	Pick Systems	Software	Development
	Corning	Fibre optic cabling	R&D
Slovakia	Bull	PCs	Assembly
	Alcatel	Telecommunications	Assembly

Table 14
Overview of major ICT production and manufacturing investments

Note: This listing is not comprehensive.

While Poland has received the largest share of FDI in the region, Hungary has seen more direct investment in ICT production designed for export. In addition to a number of investments in telecommunications equipment for local consumption, outside companies have set up assembly facilities for a variety of IT products, with a particular focus on peripherals. The country has also attracted notable investments in basic ICT-related R&D and software manufacture, considering the large local base of highly qualified programmers. The Czech Republic has only recently drawn the attention of companies aside from those firms involved in modernising the country's telecommunications equipment infrastructure. Unique for the region, several IT vendors are conducting PC assembly for re-export to Western Europe. ICT production investment in Poland appears to be directed more toward the local market. Equipment assembly in telecommunications and peripherals is largely designed for local resale. The few exceptions here are assembly units established for peripherals which are being re-exported to Western Europe. Some investment has been directed to R&D, particularly in the Southern part of the country.

There are no major investments in computer hardware in Russia. Russian tax legislation and the import-export regime undermine any kind of manufacturing operation, particularly for exports. Not only are such ventures highly taxed, but it is nearly impossible to export any finished products. Moreover, several PC assembly operations initiated by international vendors have been stopped, despite their focus on local consumption. Given that the choice of city telephone switches is more political, there are advantages in telecommunications companies establishing local assembly operations. These became strategic given the equipment buying bonanza which ensued after Sviazinvest was privatised. There are also very few major investments in software.

The various countries of Central and Eastern Europe have all set up agencies to promote investment in the region, including in ICT production. Hungary has gone the furthest in seeking to attract investment in research and development with the support of an agency called the Investment and Trade Development Agency (ITD). The country has set out a range of policies to draw capital inflows into targeted areas such as electronics, software, automotive parts, textiles, engineering, pharmaceuticals and tourism.

Similarly, the Czech Republic retains an organisation called Czech Invest to promote FDI. The Czech government approved a new foreign investment incentive package in April 1998 which includes a five-year corporate tax waiver, followed by a tax bonus equal to the amount waived; a waiver on customs duty on some imported machinery; the creation of a special customs zone for production plants; training grants; job-creation grants for companies employing Czech nationals in certain underdeveloped areas of the country; and land sales at artificially low prices in some areas.

Slovakia has established the Slovak National Agency for Foreign Investment and Development (SNAZIR) to promote investment in the country. The country offers incentives such as the duty-free and VAT-free import of machinery, double taxation and investment protection agreements, official financial support for investments in regions where new job creation is undertaken, and liberalised regulations for the import of goods and components used in further local production. More recently, the government introduced a new ten-year tax exemption for foreign investors.

Poland also offers several incentives to investors such as tax credits, profit repatriation, specific exemptions on VAT for technology development and export tax credits. Several special industrial and commercial zones have also been established such as sites in Wroclaw and Lodz. Slovenia Russia and Estonia do not field concrete programmes to promote investment in specific areas such as ICT.

3.4. Software development as an industry opportunity

While most of the original ICT manufacturing base has disappeared in Central and Eastern Europe, software represents the one area in which local companies have successfully competed as niche vendors, due in part to their competitive cost base. Aside from a relatively large number of firms in the region which now export software internationally, an even greater number are involved in activities such as custom software development, localisation, implementation and maintenance support, for both locally developed and international packaged application solutions and tools.

Software development as an industry opportunity in Central and Eastern Europe can be divided into the following categories: (1) custom software development, (2) localisation, (3) body shopping, (4) professional services and (5) packaged application solution development. Strong

Table 15
Overview of local software production firms (exports) for selected Central and Eastern European Countries

	Company	Expertise
Overview of software companies in Hungary	Graphisoft	CAD, AEC, solid modelling
	Recognita	Image processing, OCR
	IQ Soft	RDBMS, systems integration, AI, OA, C/S development, Oracle. Gupta
	Electronic publishing services	PC-based application development
	Mikro Volan Elektronika	Accounting and IT, Clipper-oriented development
	IPM Software	Accounting and IT, Clipper-oriented development
	IBIS	Structured systems development, software engineering methods, SSADM, Prince, QA
	Szamalk Group	Software systems design
	Integra	Bank and IT, securities and IT, production control, graphical solution
	Flexiton	Graphical information processing
	Carto Hansa	Special MAP expertise
	Geoview	GIS (OS2 and Unix)
	Aszsz	GIS
	Geometria	GIS, Map – database management
Overview of software companies in Poland	COMARCH-EGERIA	ERP-based application
	LOGOTEC –	CAD/CAM
	Eureka System –	Application for lottery games
	COMTEC –	Telephone billing
	DGT	Telekommunication applications
	Softbank	Banking applications
Overview of software companies in Russia	ELVIS+	Applications for data security/encryption, wireless computer networks and electronic payment systems
	ABBYY	Optical character recognition, handwriting recognition, machine translation software and document management software
	Cognitive Technologies	Document management, search and retrieval solutions, electronic data warehouse solutions, high-volume paper documents and structured forms input, optical character recognition systems, linguistic text analysis technologies, speech recognition and text-to-speech technologies
	ProMT	Automated translation products
	Reksoft	Billing systems for small, PBX-based operators, hotel management systems
	Dialogue Science	Anti-virus software
	Kasperskaya Laboratory	Anti-virus software
	Epsylon Technologies	Software development tools for Internet applications
Overview of software companies in Slovenia	Aster	– Banking: KART – Global information system. – Retail & logistics. – Financial & accounting
	Edico	Edico Tour
Overview of software companies in the Czech Republic	Grisoft	Anti-virus software
	AEC	Anti-virus software
	Alwil software	Anti-virus software
	AEC	AEC applications
	Software602	
	D-Data	Multimedia education applications
	Cadis	CAD/CAM/AEC/GIS applications
	AB Studio	
	FBL Group	
	PragoData	

international competition, the limited size of local markets, and extensive costs for R&D have made it difficult to sustain any kind of long term development of local packaged applications, with the exception of the accounting area where some economies of scale are available. As a consequence, most local firms involved in software development function as support organisations for international vendors offering software solutions in this regional market, with a particular focus on localisation, customisation, implementation and maintenance.

Nevertheless, a number of software firms in Central and Eastern Europe are now involved in some type of software export activity, ranging from simple body shopping to the actual development, manufacture and sale of packaged solutions abroad. *Table 15* provides an overview of companies in the region which have developed applications for export. Most have focused such activity on a particular niche segment (generally tools) where R&D expenses generally reflect costs and time for personnel.

3.5. Overview of trade in ICT products and services

The absence of a real competitive structure for ICT manufacture in Central and Eastern Europe limits the amount of two-way trade in ICT products and services. Consequently, most trade consists of imports of ICT products for local use from the European Union, the Far East and the United States, with services provided locally. Exports are generated through: (1) the redistribution of ICT products assembled for international vendors – items are generally shipped to Western Europe with only minimal local consumption, (2) packaged software solutions, and (3) custom software development with activities such as body shopping and frame contract work.

Exchange rates

	1994	1995	1996	1997
Czech Republic (Crowns)	33.6	33.4	34.4	40.3
Hungary (Forints)	126.1	193.7	185.4	237.1
Poland (Zlotys)	2.7	3.5	3.5	4.2
Russia* (Roubles)	2,929.50	6,834.00	6,248.00	n.a.
Slovakia (Crown)	37.1	39	38.6	42.6
Slovenia (Tolars)	n.a.	n.a.	n.a.	205.6
Estonia (Kroons)	n.a.	n.a.	n.a.	17.6

* Russia: research is carried out using US Dollars rather than Roubles. The Russian currency's steep devaluation makes local currency research impossible (e.g., in December 1995, the Rouble to ECU exchange rate was 7,140 Roubles to the ECU).

Glossary

CPI	Consumer Price Index
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
EU	European Union
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GSM	General Special Mobile
ICT	Information & Communications Technology
IT	Information Technology
NATO	North Atlantic Treaty Organisation
OMFB	National Development Technical Committee (Hungary)
R&D	Research and Development
VAT	Value Added Tax
WIPO	World Intellectual Property Organisation

The ICT market in the Mediterranean basin

This paper has been provided by IDATE in close co-operation with the EITO Task Force.

1. General overview of the overall Mediterranean basin

The Mediterranean basin is an area displaying numerous peculiarities and great geopolitical complexity: one of the principal cradles of human civilisation, the Mediterranean has always been a meeting place, a setting for economic, cultural and human exchanges between East and West.

The European Union's (EU) relationship with the Mediterranean non-member countries has been greatly influenced by factors such as geographical proximity, traditional economic independence and, finally, close historic and cultural links. The earlier stages of the European Union's Mediterranean policy were characterised by an approach where each country in the region was considered individually which led to a series of limited bilateral agreements. However, given the developing trends within regional associations, which were also evident in the European Union's other global co-operation agreements, new policies were developed.

The co-operation agreements concluded by the European Union with the Mediterranean countries in 1976 led to a five-year financial protocol, the fourth round of which ended in 1996. These have been financed by the European Union's budget and by loans from the European Investment Bank's (EIB) own resources. As regards the fourth protocol (1991-1996), 2,375 million ECU (EU and EIB) were allocated by each country to cover the financial co-operation (bilateral co-operation). Considerable additional financial aid is also allocated for regional and horizontal co-operation.

This new approach paved the way for the Euro-Mediterranean partnership inaugurated at the Ministerial Conference in Barcelona in November 1995, which for the first time brought together representatives of the European Union and 12 Mediterranean partners: Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Syria, Tunisia, Turkey and Palestine.

The Barcelona Conference saw the adoption of the Euro-Mediterranean partnership, a new form of economic, political and social co-operation and an action programme.

Definition of the Mediterranean basin

Maghreb	**Morocco** **Algeria** **Tunisia**	Libya Mauritania
Machrek	**Egypt** **Jordan** **Lebanon** **Syria** **Palestine**	Iraq Saudi Arabia Bahrain UAE (United Arab Emirates) Kuwait Oman Qatar Yemen
Eastern Mediterranean	**Israel** **Malta** **Cyprus** **Turkey**	Albania Yugoslavia Bosnia Croatia Slovenia
European Mediterranean		France Greece Italy Portugal Spain

Arab countries as defined by the International Telecommunication Union, 21 countries
Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, UAE (United Arab Emirates), Yemen.

MENA: Middle East and North Africa (geopolitical definition), 23 countries
Algeria, Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, UAE (United Arab Emirates), Yemen, Palestine

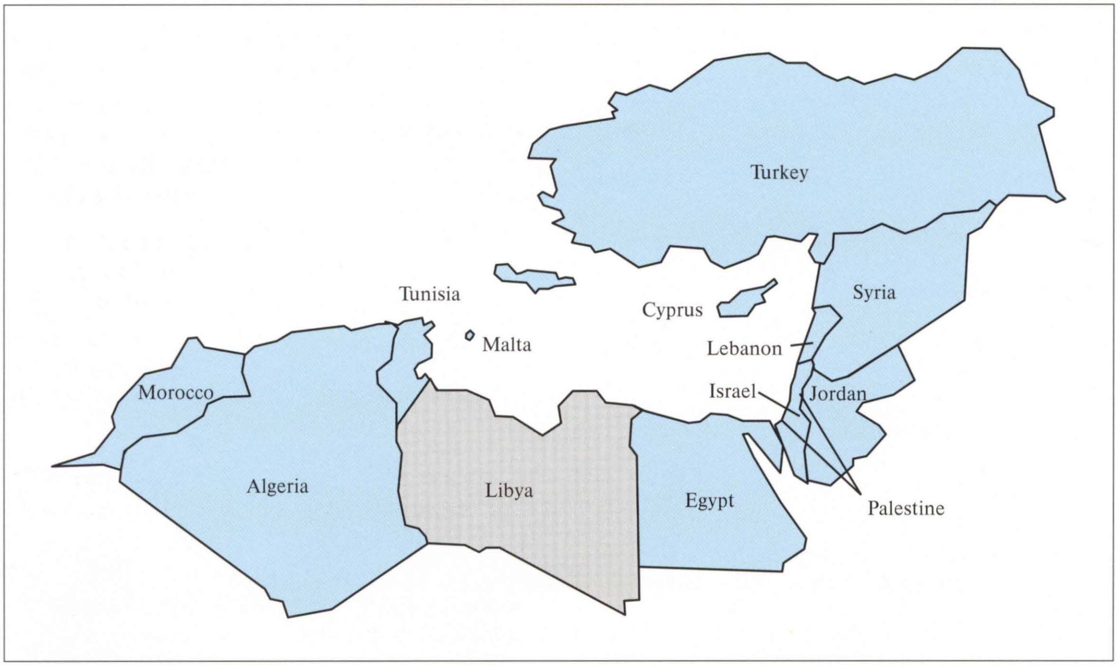
The main regional organisations

Arab League, 22 countries
Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, UAE (United Arab Emirates), Yemen.
Its objective is to defend the interests of the member states and strengthen mutual relations, to co-ordinate political measures with a view to achieving close co-operation and to safeguard their independence and sovereignty.

Arab Maghreb Union – UMA, 5 countries
The *Union du Maghreb Arabe* was created in 1989 by Algeria, Libya, Mauritania, Morocco and Tunisia to lay the foundations for a Maghreb economic area.

The Southern and Eastern Mediterranean Countries – SEMC, 12 countries
Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, Palestine, Syria, Tunisia, Turkey.
These 12 Mediterranean countries which have a privileged political and economic relationship with the European Union since the Barcelona Conference of November 1995.

1.1. Major characteristics/differentiation of the twelve EU Mediterranean partners



The different levels of development among European and Mediterranean partners, the huge disparities in GDP per capita, in income and in wages and the high rate of trade dependence of Mediterranean partner Countries on the European Market may constitute barriers to a successful and equitable partnership.

In commercial exchanges, only Algeria enjoys a trade surplus with the European Union and only Algeria and Malta come close to balanced current accounts.

As a result of trading, tourism and migratory movements, the Mediterranean partners are firmly integrated in the European area but poorly mutually integrated, with inter-regional trade corresponding to less than 10% of total foreign trade. There has been some growth in intra regional commercial exchanges: Between Israel and Turkey there is strong and sustained commercial activity (ECU 450 million in 1997).

With some 180 billion ECU of government foreign debt, the Mediterranean countries have to disburse annually some 15 billion ECU for debt servicing.

1.2. Demographic situation and trends

The general picture is of a rapidly growing population in the developing countries of the region: for the 12 countries, the population of 231 million at the end of 1998 is expected to reach 240 million at the end of 2000, which represents an annual growth of 2%. Between 1985 and 1995, the average growth of Mediterranean countries was more than 2% a year, whereas in the 15 European Union countries, the average was 0.4%.

Table 1
Population in the 12 SEMC and the 15 EU countries (millions)

	1996	1997	1998	1999	2000
12 SEMC	221,7	226,3	231,1	235,9	240,9
Growth rate (%)	2.2	2.1	2.1	2.1	2.1
15 EU	373,2	373,8	374,3	374,8	375,2
Growth rate (%)	0.2	0.2	0.1	0.1	0.1

Source: Eurostat

The structure of the age pyramid is also very characteristic: young people (under 15) represent more than 30% of the total population (against 17% in the EU) and old people (over 65) only 5% (against 16% in the EU).

Two countries (Egypt with 64 million and Turkey with 65 million) represent half of the total population and more than half of the population lives in cities with an urban population growth four times higher than in the EU.

Natality in Mediterranean countries is between 3 and 3.5% with great differences (5.8% in Syria; less than 2.5% in Cyprus or Israel).

The status of women in the Mediterranean world has changed rapidly, with family planning programmes in countries such as Egypt, Morocco or Tunisia. More and more women are working (one worker out of three is female).

In several European countries, the migration of workers and the family regrouping that followed in the wake of the restrictions imposed on workers' movements, led to the development of a Mediterranean population that now accounts for a large part of the foreign population in Europe.

Of the Mediterranean residents in the EU, close to 4.7 million are either of Turkish nationality (2.4 million, of which 1.8 million in Germany) or of Maghrebi nationality (2.1 million, of which 1.4 million in France, mainly from Morocco and Algeria).

1.3. Current economic situation and prospects: a market in transition

The Middle East peace process, the creation by 2010 of a Mediterranean Free Trade Area between Mediterranean countries and the European Union and the implementation of a series of structural reforms constitute the key events in this region as the century draws to a close.

The process of economic reform (under the aegis of the World Bank and International Monetary Fund) has been engaged in a differentiated manner during the last decade (particularly strong in Morocco, Tunisia and Jordan) and accompanies the integration of the SEMC in the world economy.

Most SEMC have recognised the need for economic reforms to fight the combined effects of unsustainable balance of payment deficits, falling oil prices, the new competition with countries from Central and Eastern Europe and market liberalisation in the framework of the WTO.

The Mediterranean basin as a whole can be characterised by a slowing down of economic growth in the 1990's with a global growth estimated at 4.5% until 2000.

The aggregate GDP of 12 SEMC corresponds to around ECU 500 billion in 1998 (comparable to the Spanish national market) and accounts for 6-7% of that of the EU 15.

The breakdown of economic growth reveals some major characteristics:

- the very sensitive position of agriculture in SEMC (between 15 and 20% of the GDP for an active rural population constituting between 25 and 30%) and the heavy dependence of harvests on climatic conditions (except in Egypt) which induces a high average level of alimentation dependence;

- the absence of a diversified and competitive industry except in some specialised sectors (textile; agribusiness, etc.) and in countries like Israel and Turkey;
- the ongoing process of privatisation of production, liberalisation of the economy and structural adjustment programmes.

The needs of the region in terms of infrastructure remain huge and the policy adopted in various Mediterranean countries, e.g. Morocco, is to attract foreign private investment. So far, Mediterranean partners attract only a tiny share of foreign investments.

The peace process between Israel and the Arab states is a guarantee in the long term of economic stability and regional security: the various private and public partners are placing their bets on an increase in investment bound up with its pursuit. A number of initiatives have been generated: annual conferences, regional co-operation institutions including the Middle East and North Africa Development Bank situated in Cairo agreed to support these regional co-operation measures.

The peace process will generate different economic perspectives: reduction of state defence expenses; growth in business co-operation and regional tourism; the prospect of regional economic integration with the growth of trade in the zone and particularly between Israel, Egypt, Jordan and Palestine.

Nevertheless, the difficulties in following the Oslo agreements between Israel and Palestine are a proof of the fragility of the process.

1.4. Relations with European countries and role and initiatives of the European Union

Europe is the natural area for the integration of Mediterranean countries with an international economy. The Mediterranean basin has an interest in specific areas such as tourism or industrial subcontracting. On the other hand, the European market is of economic importance to all countries with consequent differences from one country to another.

The Mediterranean partners represent 12% of EU exports and the EU around 50% of the Mediterranean partners' exports.

Falling oil prices have left the Mediterranean non member countries with a soaring deficit on trade with the Union (ECU 17.3 billion in 1997). This imbalance is at least partly attributable to the fact that the Mediterranean countries exports are heavily concentrated in a limited number of sectors or products, but present differentiation from one country to another.

In the framework of new Euro-Mediterranean policy and creation of a free trade area, major advances have been achieved: association agreements have been negotiated with the EU by 9 Mediterranean countries: Tunisia, Israel, Morocco, Jordan, Egypt, Palestine, Algeria, Syria, Lebanon.

Relations with Cyprus and Malta are guided by a pre-accession strategy; Turkey entered a customs union with the EU on 1 January 1996.

In June 1995, the Commission adopted a new financial instrument, MEDA, designed to lend support to the reshaping of the economic and social structures in the 12 SEMC.

The MEDA programme is the main component of the Euro-Mediterranean Partnership's financial endowment for the period 1995-1999, i.e. ECU 3,475 million. Entirely made up of grants, this programme has produced actual commitments of ECU 1,557 million for the first three years (1995-97) and actual payments of ECU 417 million.

In 1995 and 1996, it progressively replaced existing financial instruments, mainly the Financial Protocols, and in 1997 represented about 90% of the total financial commitments from the EU budget in the Mediterranean.

MEDA

The priorities for MEDA resources are:

- support for economic transition: the aim is to prepare for the implementation of free trade through increasing competitiveness with a view to achieving sustainable economic growth, in particular through development of the private sector;
- strengthening the socio-economic balance: the aim is to alleviate the short-term costs of economic transition through appropriate measures in the field of social policy;
- regional co-operation: the aim is to complement bilateral activities through measures to increase exchanges at the regional level.

Beneficiaries of this programme are the local authorities, regional organisations, public agencies, local or traditional communities, business support organisations, private operators, co-operatives, mutual benefit societies, associations, foundations and non-governmental organisations.

The programme's activities are focused on different sectors:

- Regional Indicative Programmes
government co-operation, economic organisations dialogue and regional sectorial projects;
- at national level

1. Policy and security sector
with the objective of a peace and stability zone;
2. Economic and financial sector
with a transitional economic support to promote the creation of a free-trade area (development of the private sector, promotion of private European investment, modernisation of economic infrastructures and support for structural adjustments);
3. Social, cultural and human sector
support for developing social services, health and media;

Specific projects (micro projects or Euro-Arab co-operation)
promoting regional and cross-border co-operation within the framework of the Barcelona process and in the economic, information and cultural fields.

Over the period 1995-1997, commitments went to four main types of operations:

- support for structural adjustment: 22.4 % of total commitments;
- support for economic transition and private sector development: 9.6% of total;
- classical development projects: 52.5% of total;
- regional projects: 15.5% of total.

Under the partnership arrangements, the European Investment Bank is committed to lending up to ECU 2,310 million between 1997 and 2000 for investment projects in 12 non-EU-Member Mediterranean countries.

In 1997, a record ECU 1.1 billion (37% of total commitments in 1997) financed investment in ten non-EU countries, primarily in the framework of the Euro-Mediterranean Partnership. The emphasis was on projects encouraging the liberalisation and privatisation of their economies and helping the private sector to restructure and expand, in sectors such as energy, communications and the environment.

Table 2
Progress of negotiations on Euro-Mediterranean association agreements

Partner	Conclusion of negotiations	Signature of agreement	Entry into force
Tunisia	June 1995	July 1995	March 1998
Israel	September 1995	November 1995	–
Morocco	November 1995	February 1996	–
Palestine	December 1996	February 1997	July 1997
Jordan	April 1997	November 1997	–
Egypt	Negotiations in progress	–	–
Lebanon	Negotiations in progress	–	–
Algeria	Negotiations in progress	–	–
Syria	Negotiations in progress	–	–

Source: European Commission

ECU 200 million financed joint-ventures in industry and investment to encourage development of the private sector, including risk capital facilities in Malta, Egypt and Tunisia. The ICT projects can be found in the "industry and services" category.

Euro-Mediterranean policy on the Information Society

For the Mediterranean region, EU co-operation takes place within the framework of the Barcelona Declaration of November 1995 for a Euro-Mediterranean Partnership.

Organised in Rome on May 1996, the Euro-Mediterranean Ministerial Conference on the Information Society concluded by encouraging competition and liberalisation in the telecommunication sector and proposing a series of projects of regional interest aimed at:

- promoting the interconnection and the interoperability of trans-Mediterranean communication and information networks for economic co-operation;

Table 3
Geographical and sectoral breakdown of finance contracts signed in 1997 (million ECU) by EIB

	Total	Energy	Communi-cations	Water management	Industry, services	Global loans
Africa, Caribbean, Pacific (ACP)	60	39	3	0	2	16
South Africa (RSA)	199	45	0	0	0	154
Mediterranean (MED)	1,122	346	310	265	65	136
Central and Eastern Europe (PECO)	1,486	70	804	520	47	45
Asia and Latin America (ALA)	378	93	75	65	105	40
Total	3,245	593	1,192	850	219	391

Source: EIB

Table 4
Agenda of Euro-Mediterranean Information Society workshops and conferences

Satellite Communications	Cairo, Egypt, 26-27 May 1997
Electronic commerce	Metsovo, Greece, 4-6 July 1997
Piloting Information Technologies – Solutions for Industries and Services	La Toja, Spain, 10-12 October 1997
"EURO-MED NET '98: The Role of the Internet and the WWW in the Development of the Euro-Mediterranean Information Society"	Cyprus, 4-7 March 1998
Information Society Technologies in Healthcare	Tunis, Tunisia, 17-18 April 1998
Development of multi-destination tourism	Cagliari, Italy, 29-30 April 1998
"Multimedia Access to Euro-Mediterranean Cultural Heritage"	Cairo, Egypt, 27-28 April 1998
"Multimedia Technologies . . . Towards a Euro-Mediterranean Multimedia Industry"	Malta, 29-31 May 1998
"Policies and Business Strategies for a Euro-Mediterranean Information Society"	Istanbul, Turkey, 15-16 June 1998
The use of multimedia and other technologies in education and training	Marrakech, Morocco, 19-20 October 1998

Source: Euro-Mediterranean Information Society Steering Committee

- placing research and technological development at the service of the Information Society and social and economic expansion by establishing links between European and Mediterranean partners;
- putting the new technologies at the service of human resource development in order to enhance education and training and the growth of the Information Society.

Results of the **Euro-Mediterranean Information Society Action Plan** are at a political level a growing awareness of the potential impact of the Information Society technologies on virtually all spheres of public and economic life. A high-level group, the Euro-Mediterranean Information Society Action Plan Steering Committee, was set up and inaugurated directly after the Rome Ministerial Conference.

An action plan drawn up in the MEDA framework covers actions of regional interest and proposes synergy between the various instruments for structural adjustment, in particular by providing support for adaptation to the regulations, a dialogue through a Forum on the Information Society, accompanying support for the restructuring of telecommunications, and training. In 1998, the MEDA committee approved funding for a DG XIII programme valued at 2.7 Million ECU, to promote the creation of regional Telecommunications fora, promotional actions, working groups and a Virtual Mediterranean Telecommunications Observatory. The launch of an assistance programme named Eumedis to promote Euro-Mediterranean pilot projects in specialised fields: health care, electronic commerce, tourism/cultural heritage, IT in industry and innovation, space technology applications, research and education networks, has been budgeted (ECU 45 million).

Specific programmes relative to ICT

- Medstat is an important regional co-operation programme in the Mediterranean which aims to harmonise the statistics of the European Union and its Mediterranean partners: statistical offices of Member States, Mediterranean partners, Eurostat and European Commission's statistical bureau. Some priority sectors have been identified such as statistics on information systems (also tourism, migration, transport, external trade and environment).
- The setting-up of Information Technologies Centres (ITCs) in the SEMC is being supported by the European Commission through the provision of training and monitoring measures, in particular in the areas of technologies for business processes, multimedia technologies and more broadly electronic commerce.
- INCO-DC is a DG XIII-III programme for scientific and technological co-operation with developing countries, including the SEMC, with a section on information technologies (INCO-ITDC).
- In December 1994, the European Commission established the Information Society Project Office (ISPO) – a joint unit of DG III and DG XIII – to provide a single user-friendly interface and promote the Information Society in the European Union. The ESIS (European Survey of Information Society) initiative has been running since January 1997 and has been extended to 13 Central and Eastern European and 12 Southern and Eastern Mediterranean countries.

2. Overall ICT market overview

National economic priorities have determined the development of different national models of IT and telecommunications. Generally speaking, the Information Society has been assuming reality in this region with its nevertheless strong and differentiated movements in terms of infrastructure investments, national demands or liberalisation processes. Computerisation is taking place first in the public economic area: ministries, public firms and education.

	1995	1996	1997	1998	1999	2000
Socio-economic data						
Population ('000)	219,565	221,664	226,320	231,076	235,944	240,923
GDP (billion ECU)	440.0	463.2	479.1	498.4	519.7	539.8
Per capita GDP (ECU)	2,004	2,089	2,117	2,157	2,202	2,240
Telecoms equipment						
Main lines ('000)	23,635	25,586	28,216	30,564	33,001	35,640
Main lines/100 inhabitants	10.8	11.5	12.5	13.2	14.0	14.8
Cellular subscribers ('000)	1,108	2,279.9	4,086.5	5,632	7,593	9,781
Cellular/100 inhabitants	0.5	1.0	1.8	2.4	3.2	4.0
IT						
PCs ('000)	2,040	2,520	3,024	3,618	4,343	5,207
PC/100 inhabitants	0.93	1.14	1.34	1.57	1.84	2.16
Internet users ('000)	200	414	669	1,075	1,665	2,398

Table 5
Growth trends in 12 Southern and Eastern Mediterranean countries

2.1. Market size and trends

Telecommunications

For telecommunications, the first half of the 1990s was a period of rapid growth in SEMC networks (a 12% increase during the first half of the decade). But apart from the fact that in most of these countries the level of telecoms development is below that indicated by their forecast GDP, the telecoms situation remains full of contrasts with an average of 13.3% for the zone as a whole. It is true that Israel, Cyprus and Malta have reached an equipment rate that compares to that found in EU Member States (over 40% main line penetration), but the countries of the Maghreb and the Machrek are lagging far behind (main line penetration rates of 4-7%), even though growth is strong in some of them: Morocco, for instance has tripled its main line base since 1990 but is still behind in regard to teledensity.

The structural imbalance between rural and urban areas remains a significant problem for telecommunications in the Maghreb and Machrek countries.

Turkey is a case apart because of the size of its network (over 17 million lines in 1998, more than 55% of the number of main lines in the zone) and a growth strategy that places it in an intermediate position (26 main lines per 100 inhabitants).

Thank to recent investments in networks, digitalisation has brought about a great deal of progress in the region with rates exceeding 90% in most countries.

The first telecommunication service to be privatised, the cellular service, is predicted to have a very strong growth with 9.8 million subscribers in 2000.

The state has recently begun to intervene by initiating an extensive programme of deregulation and privatisation within the telecommunications sector. This process, though well under way, is far from complete. Some countries (mainly Israel and Turkey) have already implemented a privatisation programme. Others such as Morocco and Jordan have introduced measures for partial privatisation. (Adopted in July 1997, the Moroccan law stipulates that "the capital of the national operator may be opened up in part or in its entirety to the private sector"); Jordan was planning to privatise its telecommunications operator in 1998. Changes in the status of the operator (from PTT administration in the Lebanon and Algeria) to public operator (Egypt, Jordan, Tunisia) or to a public company (Morocco, Israel, Turkey) are part of the series of reforms.

Restructuring is being driven primarily by increasing pressure to attract private capital for infrastructure development and by national economic constraints (budget deficits and external debt). SEMC governments have recognised that operators need financial and managerial autonomy to respond to the increasingly complex and fast moving telecommunications industry.

It is likely that reforms, still to occur, will be accelerated in the future as a result of the WTO Basic Telecommunication Agreement to which Morocco and Tunisia have committed themselves.

Information technology

The number of PCs is estimated at 3.6 million at the end of 1998 and is expected to experience a 20% growth rate until 2000. Nevertheless, the penetration rate on average is low (1.6% in 1998) with great differences between Israel (15%) or Cyprus and the other Mediterranean countries with an average of a 1-1.5% penetration rate. Turkey and Israel made up 72% of the overall total in 1998.

American presence is very strong with major American software firms expanding their networks or setting up their offices all over the region. In some Mediterranean countries, high software piracy was until recently a main concern for IT vendors.

Table 6
Degree of competition in telecommunications in SEMC

Country	Local	Long distance	International	Leased lines	Data	Mobile cellular	Satellite
Algeria	M	M	M	M	M	M	M
Cyprus	M	M	M	M	M	M	M
Egypt	M	M	M	M	M	C	M
Israel	M	M	C	M	PC	C	PC
Jordan	M	M	M	M	C	PC	M
Lebanon	M	M	M	M	M	C	M
Malta	M	M	M	M	M	M	PC
Morocco	M	M	M	M	M	C	M
Palestine	M	M	M	M	M	M	M
Syria	M	M	M	M	M	M	M
Tunisia	M	M	M	M	M	M	M
Turkey	M	M	M	M	M	C	M

M = Monopoly
PC = Partial Competition
C = Competition

Source: ITU

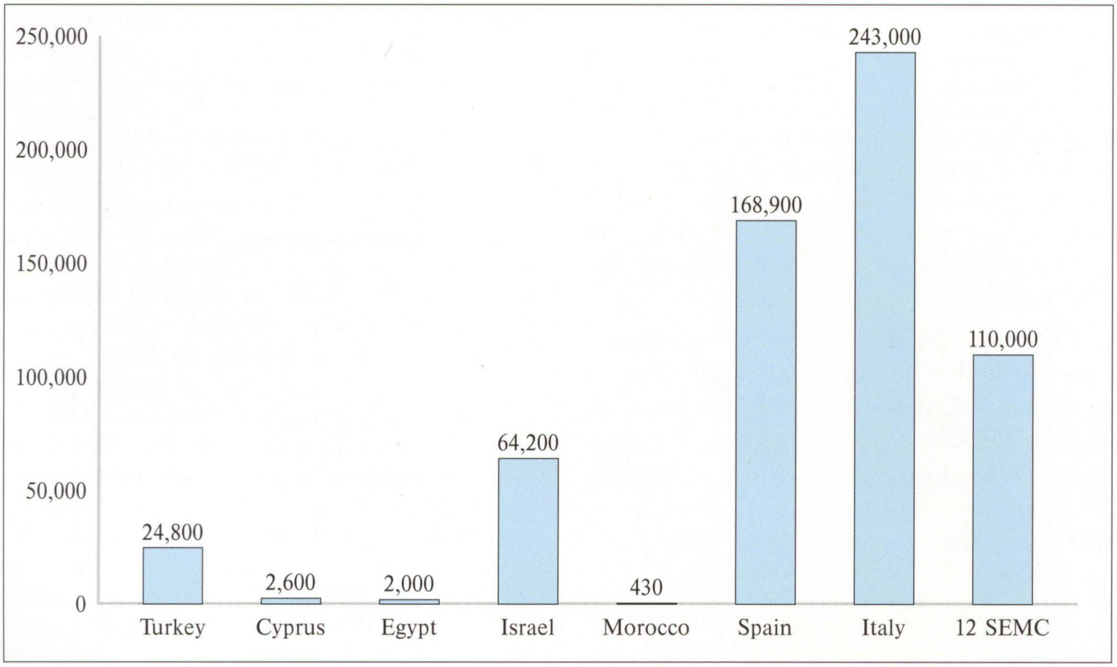


Figure 1
Number of Internet hosts in major Mediterranean countries, January 1, 1998

Source: Network Wizards

Most of the SEMC have only recently realised the economic importance of the Internet and their policies to develop this network are an essential component of a much broader telecommunications restructuring policy.

Although the academic world pioneered the development of national networks in the 1980s, the private sector, followed by government agencies have only recently become aware of the potential of such technologies. Internet connections have grown exponentially with the number of Internet users estimated at more than one million in SEMC at the end of 1998, a figure which is expected to double by the end of 2000.

Few of the SEMC have enacted legislation governing the use of the Internet but this situation has been changing very rapidly (Tunisia adopted a set of rules and regulations in March 1997).

2.2. Overview by major economic sectors

If Mediterranean countries present a rich and solid structure of small entrepreneurs (together with a number of industries active in the production of intermediate or finished goods), the global industrial sector is relatively low, except in Israel and Turkey. SMEs play a pivotal role in the socio-economic structure of the SEMC but are highly concentrated in manufacturing and very few in services.

Some specific industrial and service sectors are of importance for the Euro-Mediterranean region (e.g. textiles, the chemical and maritime industries, tourism) and will have a positive influence on the IT market in different national countries. The establishment of a modern information infrastructure should allow the Mediterranean countries to leverage on their national competitive advantages (cultural heritage, natural resources, tourism, large structure of SMEs in imports and exports).

Although traditional industries such as textiles, chemicals and agri-foods account for a significant part of Southern Mediterranean industry (25% of industrial added value in Israel, 37% in Turkey or Tunisia and more than 40% in Morocco, Egypt or Syria), the take-up of technology in these sectors alone is unlikely to lead to long-term prosperity. Mediterranean economies enjoy relative comparative advantages in terms of labour costs, especially in traditional areas of industrial activity such as the processing of leather, fibres and agricultural products, but there is increasing competition from emerging economies from Asia or Latin America. The lack of a strong industrial structure and less experience in the introduction of advanced technologies in conventional sectors are two major characteristics of the zone.

The banking and insurance sectors have undergone rapid technological transformation concentrating on computerisation and automation projects. In these sectors, the ICT services have become to play an ever-increasing role. The externalisation of certain activities becomes necessary with the dematerialisation of certain tasks carried out at an internal level. New services are beginning to be developed by the SEMC banks: vocal services for the management of bank accounts, fax servers, and the sending of files to clients' computers such as software for managing accounts. The legal boundaries in some countries are still an obstacle in the development of electronic commerce for banks, but the development of the Internet will induce them to use this tool to strengthen their position.

As regards companies, services have greatly improved with an explosion of Stock Markets: in 1997, Turkey was ranked thirty third on the world-wide scale with a Stock Market value of 39 billion ECU (out of 229 companies); Israel was ranked fifth with 32 billion ECU out of

655 companies. North African Stock Markets although more modest, are soaring (Morocco, Egypt and Tunisia) and involve important activity with regard to ICT.

The tourism sector is one of the most promising in most of the SEMC. The flow of tourists is evaluated at more than 25 million per year and represents one of the leading flows of currency into the majority of Mediterranean economies and 20 billion ECU for the zone as a whole. Tourism is an activity which is in constant progression in the region (although it is affected by political factors).

Due to the national economic structures, public administration remains the leading player with computerisation of ministries, public firms, education and research projects. In most of the SEMC public demand represents nearly 25% of each national market. The development of Academic Internet networks has been funded by public administration in most of the SEMC and school computerisation projects have been developed in countries like Egypt or Israel.

2.3. Major driving forces, opportunities and projections

As a result of the numerous national initiatives launched in the last two years, Mediterranean countries are currently making progress towards the implementation of the Information Society; but many important issues still need to be solved:

- the ability to ensure wider regional integration and improved co-operation among Mediterranean countries are core elements highlighting the special role of the Information Society with the capacity of countries like Israel, Egypt or Turkey to be regional centres;
- the creation of an appropriate business environment, thanks to regulations and the provision of targeted financial support for large pilot projects which are likely to create a consumer base for both ICT industry, content providers and business service providers;
- differences in economic development, and in public and private resources allocation for providing the necessary infrastructures in preparation for the future Information Society;
- the role of industrial investment in ICT and the pursuit of telecommunication privatisation which will also have an impact on IT use with the necessity of productivity gains;
- the growing interpenetration of economies on both sides of the Mediterranean combined with the effects of the EU co-operation programmes in ICT: long term prosperity of the Mediterranean region will also depend on development in line with developments in Europe of a mature service industry sector;
- Mediterranean SMEs have not yet introduced all telematic advantages into their production, management and marketing processes.

3. ICT market in specific countries

Five countries (Cyprus, Egypt, Israel, Morocco, Turkey) have been selected as representative of the variety of the situations and perspectives in ICT markets. In future, this study could be extended to other partner Mediterranean countries.

In *Cyprus,* the pre-adhesion process to the EU with harmonisation efforts and the geostrategic position as a hub between Eastern Mediterranean region and the Middle East have resulted in high growth in the ICT market.

Egypt is a regional leader in software production with a proactive policy in the IT field.

The *Israeli* industry is largely based on high technology sectors such as telecommunications and IT and is the technological giant of the region.

Morocco has an active policy in the field of ICT with a computerisation process and a telecommunications liberalisation.

Turkey is in an intermediary position in terms of infrastructure and is developing research and productive capacities.

3.1. Cyprus

Table 7
Growth trends in Cyprus

	1996	1997	1998
Socio-economic data			
GDP (billion ECU)	8.0	8.2	8.4
Population (thousands)	736	742	747
Economic growth (%)	2.0	2.5	2.4
Exports (million ECU)	1,160	1,070	990
Imports (million ECU)	3,240	3,020	2,890
Balance (million ECU)	-2,080	-1,950	-1,900
Tourism (million ECU)	1,510	2,330	2,542
Number of tourists (thousands)	n.a.	n.a.	n.a.
Direct investments (million ECU)	800	n.a.	n.a.
External debt (million ECU)	2,200	2,300	2,500
ICT data			
PCs (thousands)	301	330	364
Main lines (thousands)	366	379	396
Cellular subscribers (thousands)	71	94	122
Internet users (thousands)	5	8	14

3.1.1. Economic situation and expectations

Cyprus has a record of successful economic performance, reflected in rapid growth, full employment conditions and external and internal stability, almost throughout the post-independence period. In terms of per capita income, currently estimated at ECU 11,240, Cyprus is classified among the upper middle-income countries.

The success of Cyprus in the economic sphere is attributed, among other factors, to the adoption of a market-oriented economic system, the pursuance of sound macroeconomics policies by the government as well as the existence of a dynamic and flexible entrepreneurial community and a highly educated labour force. Moreover, the economy which had a 2.5% growth in 1997 benefited from the close co-operation between the public sector and the social partners. During the last decade, relations with the European Union, the largest trading partner of Cyprus, have been governed by a Customs Union Agreement, signed in 1987, which basically provides for a gradual and mutual dismantling of trade barriers and since March 1998 there has been an active pre-adhesion process.

The EU is already Cyprus' main trading partner, accounting for about 50% of total trade. Furthermore, about 73% of tourist arrivals come from the EU.

The Cypriot economy is founded mainly on services (agriculture and industry amounting to 4.7% and 13.5% respectively in 1997). Tourism and transit maritime activities are two of the main sources of revenues. So is the presence of 33,000 "off-shore" firms which in 1997 brought in revenues of ECU 300 million.

A structural trade balance deficit had an impact on national indicators in 1997 (ECU 1,950 million), but the unemployment (3.4% of the active population) and inflation rates (3.6%) remain under control. On the other hand, the public deficit continued to grow at more than 5% of the GDP in 1998, in a context of a politically sensitive year with the negotiation of EU membership and the internal issue with a public debt estimated at 58.4% of GDP and foreign debt estimated at 29.8%.

3.1.2. Major factors influencing the development of the ICT market

The evolution of the national economy, the pre-adhesion process to the EU with harmonisation efforts and the geostrategic position of Cyprus as a hub between East Mediterranean region and the Middle East have resulted in high growth in the ICT market.

National strategy in the IT field has been focused on the creation of a modern infrastructure in order to promote Cyprus as a regional pole and the encouragement of competition in the Cypriot IT market.

3.1.3. Government role and initiatives

A process of liberalisation is in progress, where the aim is to bring Cypriot telecommunications legislation closer to that of the European Union. The liberalisation process should be carried out in stages and achieved by the year 2003, with as the main changes: the transformation of status of the national operator into an independent entity before 2000, the adaptation of the regulation and the creation of a control organ in 2000.

To achieve total harmonisation of the telecommunications sector with EU directives, specific measures concerning the liberalisation of telecommunications services and networks will gradually have to be taken.

In the IT field, an ad-hoc Information Society steering committee was set up by the Minister of Communications & Works. The committee has since completed its report on the Cyprus Information Society Government Action Programme, which has been used as the basis for the announced Information Technology policy: creation of a modern infrastructure, institution of a coherent juridical and legislative framework; dissemination of IT technologies in all productive segments; active involvement of the state.

3.1.4. IT market trends by major products/software/service categories

Cyprus is a small but developed market. It has a central position in the Euro-Med research co-operation with different projects in this field. After the announcement of the government IT policy and the signing of the agreement between the government of Cyprus and the EU allowing full participation of Cyprus research community in the EU 5th Framework Programme, a dramatic increase in the number of such projects is expected.

3.1.5. TLC market trends

Cyprus recognises the importance of telecommunications and has invested heavily in the development of this sector. As a result, the island may claim, in this respect, to be among the most developed countries in the world.

The national network uses state-of-the-art technology such as digital switching and transmission systems and fibre optic cables. Services introduced during 1997 include new value-added services such as videotex, the message handling system X.400 and ISDN services.

The capacities of the switched network and the transmission network are 67% and over 90% digital respectively. There are currently 53 lines per 100 inhabitants, which is comparable with rates found in the countries of Europe.

In keeping with its intention to make Cyprus a centre of telecommunications for the East Mediterranean region and the Middle East, the public operator has invested heavily in recent years in building an undersea fibre optic cable network, which now links the island with its neighbours (Greece, Lebanon, Syria and Israel) and gives it access to the global network.

3.1.6. Development of specific sectors

A GSM service was introduced in 1995 and the two cellular networks (GSM and NMT 900) accounted for 122,000 subscribers at the end of 1998, i.e. a 16% penetration rate.

Cyta is involved in a Euro African Satellite Telecommunication Limited Company (E.A.S.T.), a geostationary communications satellite system for Europe, Africa and the Middle East, designed to provide state-of-the-art mobile telephony, fixed telephony and data services in remote regions at competitive prices.

3.2. Egypt

Table 8
Growth trends in Egypt

Fiscal year	95/96	96/97	97/98
Socio-economic data			
GDP (billion ECU)	60.9	63.6	66.3
Population (thousands)	61,450	62,679	63,932
Economic growth (%)	4.2	4.4	4.2
Exports (million ECU)	4,175	4,482	n.a.
Imports (million ECU)	12,570	13,380	n.a.
Balance (million ECU)	-8,395	-8,898	n.a.
Tourism (million ECU)	2,735	3,314	3,961
Number of tourists (thousands)	3,133	3,896	n.a.
Direct investments (million ECU)	560	700	n.a.
External debt (million ECU)	28,300	26,200	26,000
ICT data			
PCs (thousands)	350	440	572
Main lines (thousands)	3,025	3,452	3,728
Cellular subscribers (thousands)	20	83	170
Internet users (thousands)	30	55	70

3.2.1. Economic situation and expectations

The economic reforms have enjoyed some recent successes: 4.4% growth in 1996/97, inflation under control at 7%, and a more satisfactory external situation: foreign debt fell to ECU 26.2 billion (41% of GDP).

The second phase of the structural adjustment plan has experienced a further boost, particularly for the privatisation process, which implies a growth in equipment and intermediary imports. The gradual liberalisation of trade has resulted in new imported products (such as banking software, etc.) and privatisation is open to foreign investors.

The association agreement between Egypt and the EU is in its final phase of negotiation and will lead gradually to free trade between the two partners and a reduction in tariffs.

Economic policy over the next few years has three main prerequisites:

- sustainable growth necessary to reduce an unemployment rate estimated at 20% and to improve the living standard of a population that is growing by more than 1 million a year;
- consolidation of the balance of payments with equilibrated revenues from tourism, immigrant workers and the Suez canal;
- improvement in competitiveness to cope with an increasingly strong challenge from the outside.

Priority has been given to the development of productive private investments by different means: new law on investments passed on 8 May 1997 and continuation of the privatisation process launched in the beginning of the 90s with 73 partially privatised organisations at the end of 1997, and a programme of 55 others for 1998. Nevertheless, the government remains the first national customer with public services equalling 20% of GDP.

The commercial exchanges with SEMC remain modest, the main exchanges being with the USA and Europe. 70% of Egyptian industry is still in state ownership. The industrial production remains modest, but based on a range of resources such as textiles, agro-industry or oil.

3.2.2. Major factors influencing the development of the ICT market

The liberalisation of the economy, the development of private sectors and gradual privatisation have resulted in high growth in the ICT market.

The Egyptian administration is the major player with computerisation contracts of public firms, government bodies and schools.

ICT needs have been increasing in the national economy. The private sector has a growing potential in banking and finance (with the privatisation of the financial sector which will have positive consequences for the IT market), textiles and oil with the development of accounting software packages and desktop publishing.

In the long term, the tourist industry, the country's primary source of revenue (3.3 billion ECU in the fiscal year 1996/97), will have a positive influence on the IT market.

Egypt has become a regional leader in software production in the Middle East (a high proportion is exported to Gulf countries).

3.2.3. Government role and initiatives

The Egyptian government is still very active in dealing with IT problems and wants to play a dominant role in the Middle East. It has created a number of bodies to develop the sector: for example, IDSC (Information Decision Support Cabinet) was set up to develop a legal framework to support the computerisation of public bodies in Egypt and develop a local software industry. IDSC, now attached to the Prime Minister's Cabinet, plays an important role in new legal texts (duty rights and copyright) and lends support to equipment projects (school computerisation, etc.). Its role is to assist the different ministries by offering technical assistance and software development according to their needs.

In the educational sector, the project to equip 6,000 public schools from 1998 to 2000 will bring about heavy investments in hardware.

Among its effort to encourage investment, particularly in the field of IT, the government has launched a Technology Development programme offering highly attractive incentive packages to national and foreign investors.

In the telecommunications field, 1998 has seen the beginning of the privatisation process of the public operator and the liberalisation of mobile telephony with the creation of two private operators: the law no. 19/1998 promulgated on March 1998 has corporatised Telecom Egypt and partial privatisation (20%) has been announced.

The government has also decided to allow a private company to install and operate the public payphone networks – the first time the private sector will be allowed to offer telecom services in competition with the national operator.

3.2.4. IT market trends by major products/software/service categories

Valued at ECU 452 million in 1998, Egypt's market for IT alone has the capacity to more than triple in the next five years as the population grows and government privatises industrial firms. Hardware represents 66%, software 12% and services 22% of the IT market.

In Egypt, the computer market has experienced phenomenal growth and is increasing annually (26-28% for hardware and 18-20% for software) even if it remains of limited size.

Egypt imports nearly all of its computer equipment as local production is confined to personal computer (PC) assembly only. In 1997, around 90,000 PCs were sold in Egypt, of which 5,000 were assembled locally, and the market is largely dominated by American firms.

By upgrading the nation's telephone network, the use of modems for interconnecting systems has increased. Egypt has made advances in data communication and TLC equipment.

The market for mainframes has reached maturity but is small with 40 mainframes installed: firms are already equipped and keep the same supplier.

The market for mini-computers involves insurance and banking, while the workstation market is limited to the defence and engineering sectors.

Hardware demand is influenced by the public sector which represents 20% of national consumption before finance and industry: the government has initiated a programme to equip schools and the administration with PCs, which accounts for more than 30% of local demand. SMEs in comparison account for less than 10% of the national demand.

The software and services market is estimated at ECU 152 million, of which half is developed locally, and has an annual growth of around 20%. Egypt has a leading role in software publishing for the Arab world: 80% of software exports go to the Persian Gulf and especially to Saudi Arabia.

As for hardware, the administration is the first consumer of software with a quarter of the market; oil, banking, health and tourism sectors present the most interesting opportunities. Promising software markets exist equally in office automation.

The Egyptian government passed a Law on intellectual property in 1994, which ensured that computer software was afforded specific protection, and the customs duty on software imports has been reduced from 30% to 5%.

3.2.5. TLC market trends

The total market for telecommunications equipment in Egypt reached ECU 900 million in 1998 and the services market is estimated at ECU 740 million. The global TLC sector has enjoyed a 8.6% increase in 1998 which will go on in the future due to new infrastructures and competition process.

3.2.6. Development of specific sectors

The use of the Internet is fairly developed, with 34 ISPs (Internet Service Providers) and 70,000 users at the end of the fiscal year 1997/98.

Egypt is one of the SEMC that is very well equipped in terms of academic and professional networks.

In 1998, Egypt span-off the mobile operations of Telecom Egypt and created a new private operator for mobile cellular. The development of cellular telephony is expected to remain very strong with a new operator becoming operational in 1999. The number of users is expected to increase from 170,000 in 1997/98 to around 600,000 in 2000.

3.3. Israel

Table 9
Growth trends in Israel

	1996	1997	1998
Socio-economic data			
GDP (billion ECU)	90	91.8	94.8
Population (thousands)	6,020	6,119	6,219
Economic growth (%)	4.4	2.0	3.3
Exports (million ECU)	18,800	20,300	23,400
Imports (million ECU)	27,100	28,700	28,200
Balance (million ECU)	-8,300	-8,400	-4,800
Tourism (million ECU)	1,906	2,450	n.a.
Number of tourists (thousands)	2,800	3,000	n.a.
Direct investments (million ECU)	n.a.	3,400	n.a.
External debt (million ECU)	43,700	47,300	n.a.
ICT data			
PCs (thousands)	670	798	917
Main lines (thousands)	2,539	2,674	2,858
Cellular subscribers (thousands)	1,050	1,800	2,100
Internet users (thousands)	240	350	500

3.3.1. Economic situation and expectations

The Israeli economy is the most dynamic and developed of the zone, even if it has visibly slowed down in the past year with a 2% growth in 1997.

Strongly tied to Northern America and Europe, Israel is the second foreign presence with one hundred firms traded on the New York Stock Exchange, but the Israeli economy, on the other hand, has little mutual activity with its near geographical environment (less than 10%), whereas commercial exchanges have grown tremendously with Turkey.

Israel's trade agreements with Europe and the United States, as well as the economy's exposure to competing imports, contributed greatly to structural changes with an orientation toward high-tech industries in which the economy enjoys a comparative edge. The peace process, which began with the Madrid Conference in 1990, and the weakening of the Arab boycott, served as a major impetus for the development of trade, expressed in the opening of new markets to Israeli exports and the strengthening of existing ones.

The Israeli industry is largely based on high-technology sectors such as telecommunications, IT, electronics which have a growing role (two thirds of industrial production) with a total activity of ECU 6.5 billion (of which ECU 5.1 billion exports) and a 20% growth rate.

Capital risk funds amounted to ECU 1.3 billion in 1997, allowing the creation of some 200 start-ups. Foreign investments increased in 1997 to ECU 3.4 billion despite the freezing of the peace process.

3.3.2. Major factors influencing the development of the ICT market

The transition to the production of high-tech products was enabled by the skilled manpower in Israel, where the percentage of engineers in the workforce is the highest in the world.

Under the impact of gradual liberalisation, the privatisation of the national operator and private initiatives, the Israeli telecommunications landscape is undergoing rapid change.

At the same time, faced with increasing competition, the operator has launched a restructuring programme. At present, the parent company is still responsible for managing the domestic network and separate subsidiaries operating advanced services in mobile and paging services, international services and projects, services destined for professionals, supply and maintenance of equipment, and news services.

In Israel, the IT infrastructure is very well developed, particularly in business, education and homes. The number of installed PCs is estimated at more than 900,000 at the end of 1998, with a penetration rate of 15%. The computerisation of schools is well advanced with one PC for every 10 pupils.

3.3.3. Government role and initiatives

Where regulation is concerned, the Telecommunications Act of 1982 was amended in 1992 to promote the liberalisation of international services, value-added services and satellite communications. Today, mobile and international services are open to competition, with foreign companies free to invest heavily in national operators.

Israel's domestic telecommunications network will be thrown open to competition by January 1999 as part of the government's plans to lower prices and dismantle monopolies.

Licences for the domestic market will be issued for 15 years but investors will have to provide infrastructure, transmission and telephony services and build their own facilities.

The Israeli authorities were very early in anticipating Internet development by investing in high-performance infrastructures. The Israeli Academic Network, ILAN, which was created in 1988 (based on the Bitnet network) today provides a service to all universities and research institutes in the country.

3.3.4. IT market trends by major products/software/service categories

The IT Israeli market is expected to grow 13% in 1998 to ECU 2,353 million.

The main hardware producers have opened local subsidiaries and the market is estimated at ECU 1,070 million.

The software sector is very strong in Israel with 18,000 computer specialists and a global activity of ECU 1,412 million. The Israeli software industry has the highest value added in relation to other industries in the country.

The software sector is also changing with the strong trend towards outsourcing, and the competitive advantage of Israeli software companies is based on a process of quick development and the development of unique products and technologies for niches and pioneering technological spheres. The demand from Israeli industrial firms is oriented towards Year 2000 conversion and global management systems.

The local supply in software is particularly strong with 300 software houses: exports from the software industry exceeded ECU 900 million in 1997 with a high potential for growth. Information security and network management products contribute the most to exports and constitute nearly 20% of all software exports. The main markets are the USA (38% of exports) and European countries (37%).

3.3.5. TLC market trends

The telecoms penetration rate in Israel is now approaching European levels (2.8 million lines, i.e. 46% at the end of 1998) and the number of lines is rising annually by 5-7%. The telecommunications infrastructure in Israel relies today on a system of underground optic fibres and digital exchanges.

The field of telecommunications equipment constitutes one of the most dynamic sectors in Israeli industry (estimated at ECU 1,200 million in 1997) and boasts top-level national companies. The structural changes being implemented in the telecommunications industry, including the opening of the international calls market to competition and the advanced technology available in Israel guarantee the continued accelerated development of this industry.

3.3.6. Development of specific sectors

In the mobile sector, two operators are competing. A call for a tender for a third licence (GSM) was issued in July 1997. Over a period of 18 months, the number of subscribers has risen to 2.1 million at the end of 1998 giving a penetration rate of 34%.

The past three years have seen the emergence of small companies offering value-added services, many of which are based on the Internet (Volcatec, for example, which has developed a system of telephony on the Internet). There are some 500,000 Internet users in Israel serviced by a few dozen access providers and the Israeli Internet backbone is well developed.

The cable penetration rate is very high (almost 70%) and cable networks are configured for interactive services. The country has five cable operators, each with a monopoly in its region. Tel Aviv operator offers pay services (4 channels) and is planning an Internet connection.

3.4. Morocco

Table 10
Growth trends in Morocco

	1996	1997	1998
Socio-economic data			
GDP (billion ECU)	33.5	30.3	31.5
Population (thousands)	26,853	27,310	27,774
Economic growth (%)	12	-2	4
Exports (million ECU)	3,850	4,158	n.a.
Imports (million ECU)	6,697	6,970	n.a.
Balance (million ECU)	-2,847	-2,812	n.a.
Tourism (million ECU)	1,090	1,057	n.a.
Number of tourists (thousands)	1,638	18,832	n.a.
Direct investments (million ECU)	375	1,120	n.a.
External debt (million ECU)	17,400	17,300	n.a.
ICT data			
PCs (thousands)	250	300	350
Main lines (thousands)	1,251	1,378	1,515
Cellular subscribers (thousands)	42.9	74.4	148
Internet users (thousands)	5	10	13

3.4.1. Economic situation and expectations

Morocco has clearly opted for an economic model based on a liberal policy of market opening (via its membership of the World Trade Organisation) and a tie-up with Europe through free trade and partnership agreements.

The growth announced for 1998 with a normal agricultural campaign (+4%) will facilitate obtaining the budget resources necessary for public and social investments.

The promotion of investments is a priority axis of Moroccan economic policy and for this purpose, a law on attracting investment was promulgated in November 1995. A privatisation programme is in process which has had a positive impact on the national economy and on the growth of the Casablanca Stock Exchange.

But since it depends largely on climatic conditions and the agricultural sector, Moroccan growth is very irregular, and underlying growth (1.8% between 1990 and 1997) is only about sufficient to cope with the population increase (1.7% in the same period) and demonstrates the weakness of the industrial sector (2.5% growth between 1990 and 1997).

Morocco has initiated structural reforms and actively manages its external debt (57% of its GDP in 1997). Nevertheless, the restructuring effort decreased in 1997 (some planned measures have been stopped, such as fiscal reform, laws on competition and industrial property, etc.). The pursuit of the structural reform process and of the privatisation programme is necessary to sustain growth in the private sector. The global funds from MEDA destined to Morocco are estimated at 580 million ECU between 1997 and 1999.

3.4.2. Major factors influencing the development of the ICT market

The Moroccan environment presents a number of favourable conditions: low manpower costs and local high-level engineer skills; IT is well established in the local economic framework; there are some Moroccan centres of excellence abroad and the socio-political environment can be judged stable.

Nevertheless, the regulatory environment for business firms is too complex, the lack of transparency in public markets transactions and the absence of competition in telecommunications are a constraint for business development.

With Moroccan firms undergoing computerisation, the public market for information services can be considered as a crucial issue for Moroccan SMEs.

But the small size of the national market and the fact that domestic firms have a limited access to public markets (notably public infrastructure computerisation) are the main negative issues.

In telecommunications, the process of liberalisation/privatisation was initiated in 1997 with a new law on telecommunications, the creation of a regulation agency *(Agence Nationale pour la Réglementation des Télécommunications),* the separation of Posts and Telecommunications, the privatisation of the operator (*Itissalat al Maghrib* is currently a public company) was been programmed but not yet on the agenda.

The reform being undertaken in the telecommunications sector belongs within a more general context of gradual withdrawal by the state in its capacity of producer and operator of services and the need to involve foreign operators.

3.4.3. Government role and initiatives (plans, investments, R&D activities) in the ICT field

Morocco is trying to improve its general productivity with IT solutions and has launched a national programme in this field.

The main actions undertaken in Morocco for the Information Society are:

- the creation by the new government of a State Secretariat for IT;
- the study "Competitive Morocco", in 1996, analysing different fields of economic development: tourism, textile or ICT;
- the creation of CSTI *(Comité de Suivi des Technologies de l'Information)* an initiative of the Ministry of Commerce and Industry, which has initiated the bases for a national strategy;

- MARWAN, an academic network of research linking universities and research centres, whose goal is to connect all public and private educational institutions in Morocco and provide a link to international training and research networks;
- the development of national R&D through public centres.

3.4.4. IT market trends by major products/software/service categories and final user (public administration, business, home)

The global market in 1998 has increased to ECU 270 million, of which 55% is in equipment and 45% in services. 512 companies form the Moroccan IT sector, employing more than 4,000 people.

The home market remains very poor due to the economic conditions, the bulk of the market being liberal professions and SMEs which represent 80% of the industrial structure. Large firms and particularly banking and public administration are well equipped but the trend is towards downsizing: most administrative structures equipped with mainframes are switching to client-servers linked to PCs under open environment. The market is shared among administration (25%), banks (22%), SMEs (30%) and other sectors - liberal professions and large firms (23%).

The hardware market is dominated by European and American firms; all hardware is imported, but there is competition with intermediary trademarks. The assemblers who buy in Europe or Asia and assemble PC clones in Morocco represent around a third of the PC market, thanks to very keen prices.

The number of PCs in Morocco can be estimated at approximately 350,000 at the end of 1998 indicating market growth of 17% over the previous year.

The software market is virtually exclusively in French with nearly no applications developed in Arabic; in the near future, Morocco will become a privileged IT subcontractor for Europe due to the high level of skills, low labour costs and cultural and linguistic proximity with Europe.

The rate of software piracy is very high due to the absence of a modern protection law (law from July 1970) and the high price of software: as a consequence Windows 95 has been pushed out of sale because of piracy.

3.4.5. TLC market trends (equipment and services)

Among the Arab states, Morocco is the one with the highest telecommunications network growth during the first half of the decade (23% per year between 1990 and 1995), constituting the fifth highest growth rate in the world.

Over the past decade, Morocco has invested a sum of ECU 1,100 million: half of this was self-financed, while the other half consisted of multilateral loans, supplier credits and local loans. Between 1990 and 1995, close on 70% of multilateral aid in the telecommunications sector given to the Arab states went to Morocco (ECU 220 million).

Teledensity rose from 1.7% in 1990 to 5.5% in 1998. Quality has also improved, with waiting lists and line faults having been halved. But Morocco is still behind in comparison with the average in the zone and there is a considerable lag in rural telephony (a few hundred installed lines for 13 million inhabitants).

Telecommunication revenues are estimated at ECU 853 million in 1997 and ECU 911 million in 1998 (6.7 growth rate).

3.4.6. Development of specific sectors

Diversity of products and services offered is the main objective of the operator, and in 1988 it launched a mobile radiotelephone network, subsequently enlarged in 1994 by the introduction of GSM. The network is experiencing continuously increasing demand – around 148,000 subscribers at the end of 1998, and the attribution of a second licence is in progress.

The national operator connects Morocco to the Internet via several links with a total capacity of 896 Kbit/s. 41 operational software houses have its approval for selling Internet services to Morocco for an estimated 13,000 users.

3.5. Turkey

Table 11
Growth trends in Turkey

	1996	1997	1998
Socio-economic data			
GDP (billion ECU)	169	179	187.2
Population (thousands)	63,123	64,238	65,373
Economic growth (%)	7.9	5.9	4.5
Exports (million ECU)	20,980	23,645	n.a.
Imports (million ECU)	38,602	38,777	n.a.
Balance (million ECU)	–17,622	–15,132	n.a.
Tourism (million ECU)	5,136	6,365	n.a.
Number of tourists (thousands)	n.a.	n.a.	n.a.
Direct investments (million ECU)	n.a.	n.a.	n.a.
External debt (million ECU)	72,500	75,500	n.a.
ICT data			
PCs (thousands)	880	1,226	1,695
Main lines (thousands)	14,286	15,786	17,040
Cellular subscribers (thousands)	804	1,614	2,500
Internet users (thousands)	120	200	400

3.5.1. Economic situation and expectations

As a favoured ally of the USA (member of NATO and OECD), its economic growth and geopolitical situation brings Turkey close to Europe (customs union agreement with the European Union signed on 13 December 1995). But it was not included in December 1997 in the European enlargement process.

The Turkish economy has improved quickly and continues to show dynamism (+5.9% in 1997) sustained by a very dynamic private sector and a strong informal economy in a context of economic imbalance.

The high imbalance (inflation and public deficits, aggravated by the obligation to support administrations and the public sector) calls for structural reforms (fiscal reform, social security, etc.) and a stabilisation plan to reduce inflation. Financing the deficit – foreign debt is estimated at ECU 75.5 billion at the end of 1997, while public debt amounts to ECU 23 billion, is inciting the government to speed up the privatisation process: in 1998, the sale of major public assets represented only ECU 700 million.

3.5.2. Major factors influencing the development of the ICT market

European proximity and adhesion prospects have being pushing Turkey towards greater investments in improving education, industry and technological status and has been one of the main drivers for Turkey's increasing technological sophistication in ICT.

Regarding a number of IT products, Turkey has accepted the tariff elimination approach of the World Trade Organisation, and has signed the Singapore Declaration on 13 December 1996. According to the tariff reduction timetable, customs duties and some other duties and charges are to be cut by 25% each year, from 1 July 1997 to 1 January 2000.

The telecommunication equipment sector has enjoyed a state priority aimed at modernising national infrastructures: up to the year 2000 a regular annual increase of more than 1 million lines annually is planned.

Telecommunications deregulation is in progress in mobile communications and value-added services, which are currently being operated by private companies on a revenue-sharing basis.

The setting up of Turk Telekom AS, and the privatisation pending in 1998 with the preparation of a bill allowing the national operator to keep its monopoly on basic telecom services until 1/1/2003 and establishing an independent authority under the Ministry of Transport and Communications, are the main ongoing events.

3.5.3. Government role and initiatives in the ICT field

As far as computerisation is concerned, the Turkish government has been sensitive to the issue and has made efforts to facilitate the process by reducing tariffs on computer hardware and software.

In the IT field, a law on intellectual property was revised in 1995 to cover software, influenced by Microsoft's entry into Turkey, establishing a subsidiary responsible for sales and support to all Middle East and Africa. The rate of software piracy is still estimated to be as high as 90% and is a major drag on increased software sales estimated in 1998 at ECU 180 million.

The Turkish government equally played a major role in the development of the Internet (TURNET project) and there has been a notable increase in the number of activities and projects that are under way in Turkey in the Internet field. These activities and projects may be grouped as follows:

- *Infrastructure:* There are several projects each aiming to establish an Internet infrastructure for a particular major user community including SMEs, government, Ministry of Education, police, etc.
- *Organisation:* Internet Higher Council established by Ministry of Transportation and the Prime Minister.
- *Planning:* The TUENA project aiming to produce a development plan for communication and Internet infrastructure for up to the year 2020.
- *Regulation:* The Under-Secretary of Foreign Trade established the Electronic Commerce Co-ordination Committee to investigate legal aspects of electronic commerce.

3.5.4. IT market trends by major product/service categories and final users

Turkey is rapid going through a phase of computerisation but is under-equipped in PCs with a total installed base of 1.7 million in 1998. The estimated global IT market in 1998 was ECU 1,359 million, with an annual growth of 27%.

The PC market (ECU 459 million) represents 47% of the global IT hardware market where multimedia and Internet equipment present a high potential. Hardware production in Turkey consists of mere PC assembly, but is constantly increasing.

Software and service markets are soaring with a 33% growth rate at ECU 394 million in 1998.

Finance, banking and the public sector are the main users followed by manufacturing industries and SMEs. The banking system has undergone a rapid technological transformation concentrating on computerisation and automation projects (development of on-line real-time systems and electronic banking), several banks now have country-wide electronic networks and a number of them offer direct access terminals to their major customers.

There has been minor penetration of computers into areas such as health and agriculture. The use of computers in Turkish manufacturing is steadily improving, especially for process control. Sectors like press, communication and edition are IT consumers.

3.5.5. TLC market trends

During the past decade, the telecommunications sector has enjoyed a high growth rate. With 17 million main lines subscribers, Turkey is in a privileged position (a 26% penetration rate in 1998) in the Mediterranean basin.

Positive developments in the telecommunications sector, such as intensive infrastructure investments by the operator, were reflected in the telecommunications sector exports.

There is local production of telecommunications equipment, in most cases on an OEM (Original Equipment Manufacturer) basis and the market is dominated by a number of world leaders associated with local partners, which produce the major part of national demand. Turkish manufacturers are closely following developments in European standards since the 1995 union agreement.

A significant portion of the operator's investment is allocated to automation with services such as wake-up call, itemised billing, fault reporting and operator assistance offered in all cities. The computerisation of accounting and collection of charges in all the provincial capitals has been effective since the middle of 1998.

3.5.6. Development of specific sectors

Mobile communications (GSM standard) are fairly widespread with the possible issue of a third network in the near future. Following the agreement signed by the Turkish PTT in 1993, two consortia have shared the mobiles market since 1994. The agreement originally involved revenue-sharing basis contracts, converted into licences in 1998 (ECU 450 million to operate a licence). The number of subscribers is estimated at 2.5 million at the end of 1998.

The Internet market involves a Turkish monopoly in which Turk Telekom offers a national backbone access (Turnet) and has international infrastructures. The Internet is in full expansion in Turkey with 400,000 users at the end of 1998 and around 100 PoPs (Points of Presence) operated by different ISPs. The demographic profile with more than a third of the population under 25 years of age is a favourable factor for Internet development. Turnet, the Turkish national backbone for Internet access has been established on a revenue-sharing basis.

4. The ICT potential of the area

4.1. Human resources

The Mediterranean education systems are still highly centralised and find it difficult to integrate technical and professional training. This inflexibility is found again on the job market where the scale of qualifications is defined by the level of one's diploma and one's length of service, as is the case in administration. In all the Mediterranean countries (except Israel), a lot of students study the social sciences but not many study scientific and technological subjects. In the following years, countries on the south border of the Mediterranean will witness an extraordinary growth in their needs both in basic and continuing education. Because of their increase in population, a larger proportion of their upcoming generations will be involved in higher education, at university level. Though the concerned countries are committed to providing potential resources towards education, significant improvement is still necessary as far as productivity of the educational system is concerned to meet that demand.

The lack of scientists, engineers and technicians will be felt more and more as industrial diversification develops and as technology becomes widespread. Mediterranean industries do not have a culture of on-the-job training, and due to the large population of young people, current training systems are over-stretched. Links between industry and academia remain inadequate to support the needs of a modern high-tech industry and there is only a low awareness of the role of R&D in industrial development.

Required qualifications in the up-and-coming Information Society will be different and will constantly evolve more rapidly than in the past.

In the field of human resources training, a key point of competitiveness, international recommendations have focused on:

- basic research into ICT; this means allocating more public finance to R&D, as well as greater commitment of firms to R&D investment;
- co-operation between universities and firms, which is still an objective to be achieved in all Mediterranean countries, involving sharing information on research technical applications dedicated to goods production and customer services;
- education and training, creating joint education programmes and multimedia materials that could be applied to all the differing cultural realities of Mediterranean societies in particular in co-operation with EU programmes.
- in business and commerce, recommendations are based on creating collaborative networks among firms in different countries.

4.2. Skills and expertise

The scarce resources devoted to research and development (0.5% of GDP on average) and the rudimentary nature of the science and technology systems have slowed down the development of science-based industries and hindered innovation in the traditional industries.

In this context, the current situation in the SEMC shows considerable differences both in the availability and quality of ICT infrastructures and in the generalisation of the use of applications and corresponding training. But information technology is clearly identified as a sectoral priority in different Mediterranean science and technology policies. The public research is done by a number of high quality research institutes and technical universities in different SEMC.

- The expansion of the ICT market in Israel is due to the number and the level of education of researchers and engineers, the quality of research institutes and the technological know-how developed both in military and civilian fields. The country's already high level of engineering and scientific manpower was boosted even further at the beginning of the decade with the mass immigration of Jews from the former Soviet Union.
- Most IT research and development in Turkey is carried out by Tübitak (the Turkish Scientific and Technical Research Institution) and by the larger universities such as Middle East Technical University, Bilkent University and Istanbul Technical University. There are over 70 universities in Turkey, with an estimated university student population of over 1.5 million including the open university. There are over 30 computer engineering or computer-related university departments in the country with around an estimated 4,000 students at undergraduate programmes.

Table 12
ICT market in SEMC
(million ECU)

	1996	1997	1998	1999	2000	2001
IT hardware	1,995	2,338	2,718	3,164	3,781	4,466
Software	575	668	745	860	1,010	1,190
Services	866	1,068	1,365	1,615	1,958	2,329
IT	**3,436**	**4,074**	**4,828**	**5,639**	**6,749**	**7,985**
Telecom equipment	3,865	4,195	4,462	4,750	5,065	5,342
Telecom services	7,260	7,703	8,159	8,619	9,118	9,692
Telecommunications	**11,125**	**11,898**	**12,621**	**13,369**	**14,183**	**15,034**
ICT	**14,561**	**15,972**	**17,449**	**19,008**	**20,932**	**23,019**

Table 13
Comparison between
ICT markets
in SEMC and in the EU
(million ECU)

	1996	1997	1998	1999	2000
IT SEMC	3,436	4,074	4,828	5,639	6,749
IT EU	152,609	165,802	181,558	199,335	218,541
% SEMC/EU	**2.3**	**2.4**	**2.7**	**2.8**	**3.1**
TLC SEMC	11,125	11,898	12,621	13,369	14,183
TLC EU	161,068	173,991	188,956	201,627	212,941
% SEMC/EU	**6.9**	**6.8**	**6.7**	**6.6**	**6.7**
ICT SEMC	14,561	15,972	17,449	19,008	20,932
ICT EU	313,677	339,792	370,514	400,962	431,483
% SEMC/EU	**4.6**	**4.7**	**4.7**	**4.7**	**4.9**

- Egypt has a high-level manpower in the IT field: universities have trained specialists and a high proportion of computer specialists in the Persian Gulf are Egyptian.
- Morocco has a programme of development of basic teaching and access to specialised qualifications in the IT field. The current annual total of 2,000 graduates is stated to be notably insufficient.

4.3. ICT market potentials and outlook

The global ICT market is estimated at ECU 17,449 million in 1998 and will experience an 8.9% growth in 1999.

In the SEMC, Egypt, Morocco, Turkey and Israel represent the more sizeable markets with strong growth capacity.

The IT market in the SEMC is expanding rapidly (+18.5% in 1998) with IT hardware representing 56%, software 16% and services 28%. Telecommunication activity remains predominant in the Mediterranean basin with 72% of the total ICT, but the higher growth of IT will imply a reduction of this percentage.

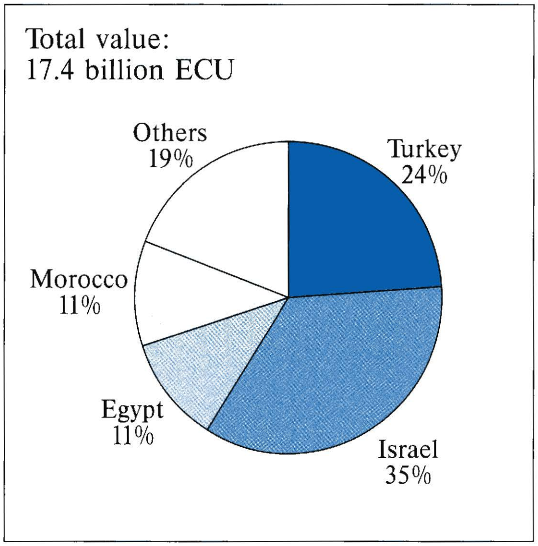


Figure 2
ICT market breakdown in SEMC by countries, 1998

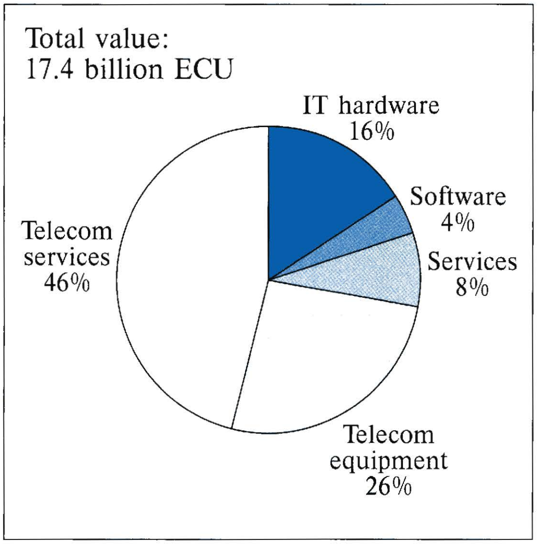


Figure 3
ICT market breakdown in SEMC by sectors, 1998

Glossary

- AMU: Arab Maghreb Union
- ANRT (Agence Nationale pour la Réglementation des Télécommunications): Moroccan National Telecommunications Regulation Agency
- Arab League: political organisation between 22 member countries
- CSTI: Committee of Information Technology Follow-up in Morocco
- Eastern Mediterranean: Israel, Malta, Cyprus, Turkey
- EIB: European Investment Bank
- Euro-Mediterranean Information Society Action Plan Steering Committee: Euromed initiative in information field
- GDP: Gross Domestic Product
- IDSC (Information Decision Support Cabinet): Egyptian body set up to support the computerisation of administrations and develop a software industry.
- ILAN: Israeli Academic Network
- IMF: International Monetary Fund
- ISP: Internet Service Provider
- ITU: International Telecommunications Union
- Machrek: Gulf and Middle East countries, e.g. Egypt, Jordan, Lebanon, Palestine, Syria
- Maghreb: 5 North African countries, e.g. Morocco, Algeria and Tunisia
- MARWAN: academic network of research linking universities and research centres in Morocco
- MEDA programme: financial instrument adopted in November 1995 by the European Commission designed to lend support to the reshaping of the economic and social structures in the 12 SEMC
- MENA (Middle East and North Africa): geopolitical definition, 22 countries including the SEMC
- NATO: North Atlantic Treaty Organisation
- NGO: Non-Governmental Organisation
- OECD: Organisation for Economic Co-operation and Development
- OEM: Original Equipment Manufacturer
- Palestinian Authority: Political authority governing West bank and Gaza strip
- PoP: Point of Presence
- SEMC: 12 Southern and Eastern Mediterranean Countries (also MPC Mediterranean Partner Countries or TMC Third Mediterranean Countries)
- TÜBITAK: Turkish Scientific and Technical Research Institution
- TUENA: project aiming to produce development plan for communication and Internet infrastructure in Turkey
- WTO: World Trade Organisation

Statistical appendix

Table 1
SEMC population (thousands)

	1996	1997	1998	1999	2000
Algeria	29,779	30,585	31,412	32,262	33,135
Cyprus	736	742	747	753	758
Egypt	61,450	62,679	63,932	65,211	66,515
Israel	6,020	6,119	6,219	6,321	6,425
Jordan	4,068	4,199	4,333	4,472	4,615
Lebanon	2,852	2,891	2,931	2,972	3,013
Malta	372	376	380	385	391
Morocco	26,853	27,310	27,774	28,246	28,726
Syria	15,385	15,928	16,490	17,072	17,675
Palestine	1,950	2,008	2,068	2,130	2,195
Tunisia	9,076	9,245	9,417	9,592	9,771
Turkey	63123	64,238	65,373	66,528	67,704
SEMC	**221,664**	**226,320**	**231,076**	**235,944**	**240,923**
Growth rate (%)	**2.2**	**2.1**	**2.1**	**2.1**	**2.1**

Source: World Bank, national estimates

Table 2
SEMC GDP (billion ECU)

	1996	1997	1998	1999	2000
Algeria	40	40.9	41.8	42.5	43.4
Cyprus	8	8.2	8.4	8.8	9.2
Egypt	60.9	63.6	66.3	68.8	71.5
Israel	90	91.8	94.8	97.6	100.5
Jordan	6.6	7.1	7.4	7.8	8.3
Lebanon	10.9	11.5	11.9	12.4	12.9
Malta	2.4	2.5	2.6	2.6	2.7
Morocco	33.5	30.3	31.5	33.1	34.7
Syria	21.8	22.9	24	25.3	26.4
Palestine	2.9	3.1	3.2	3.4	3.6
Tunisia	17.2	18.2	19.3	20.2	21.2
Turkey	169	179	187.2	197.2	205.4
SEMC	**463.2**	**479.1**	**498.4**	**519.7**	**539.8**
Growth rate	**n.a.**	**3.4**	**4.1**	**4.2**	**3.8**

Source: World Bank, national sources

Table 3
GDP growth rate (%)

	1993	1994	1995	1996	1997	1998
Algeria	- 2.2	- 0.9	3.9	4.0	2.2	2.2
Cyprus	0.7	5.8	5.6	2.0	2.5	2.4
Egypt	2.9	3.2	4.3	4.2	4.4	4.2
Israel	3.4	6.5	7.1	4.4	2.0	3.3
Jordan	5.6	8.1	6.9	5.2	7.5	4.2
Lebanon	7.0	8.0	6.5	4.0	5.5	4.0
Malta	4.0	5.0	6.2	5.0	4.0	3.0
Morocco	- 1.1	10.5	- 7.0	12.0	- 2.0	4.0
Syria	6.7	7.6	3.6	3.4	5.0	4.8
Palestine	- 10.1	3.9	- 2.4	- 2.9	6.8	3.2
Tunisia	2.2	3.3	2.4	6.9	5.7	6.0
Turkey	8.1	- 6.1	8.1	7.9	5.9	4.5

Source: World Bank, national sources

Table 4
SEMC main lines (thousands)

	1996	1997	1998	1999	2000
Algeria	1,278	1,376	1,488	1,610	1,741
Cyprus	366	379	396	414	432
Egypt	3,025	3,452	3,728	3,951	4,188
Israel	2,539	2,674	2,858	3,053	3,293
Jordan	334	386	425	468	516
Lebanon	460	550	635	698	755
Malta	180	185	200	214	226
Morocco	1,251	1,378	1,515	1,666	1,833
Syria	1,199	1,320	1,452	1,597	1,757
Palestine	83	110	120	137	152
Tunisia	585	620	707	783	867
Turkey	14,286	15,786	17,040	18,410	19,880
SEMC	**25,586**	**28,216**	**30,564**	**33,001**	**35,640**
Main lines/100 inhab.	**11.5**	**12.6**	**13.2**	**14.1**	**14.8**

Source: ITU/IDATE

Table 5
SEMC cellular subscribers (thousands)

	1996	1997	1998	1999	2000
Algeria	7.5	8.9	10	12	14
Cyprus	71	94	122	158	200
Egypt	20	83.5	170	350	600
Israel	1,050	1,800	2,100	2,500	2,900
Jordan	24	50	78	112	157
Lebanon	218	291	388	510	661
Malta	12	18	28	42	63
Morocco	42.9	74.4	148	268	455
Syria	0	6	13	24	53
Palestine	25	40	62	88	110
Tunisia	5.5	6.7	13	29	68
Turkey	804	1,614	2,500	3,500	4,500
SEMC	**2,279.9**	**4,086.5**	**5,632**	**7,593**	**9,781**

Source: Atlas of Mobiles/IDATE

Table 6
SEMC Internet users (thousands)

	1993	1994	1995	1996	1997	1998
Algeria	0.5	1	2	4	5	10
Cyprus	5	8	14	20	24	30
Egypt	30	55	70	100	160	400
Israel	240	350	500	700	850	1,000
Jordan	2	4	8	15	25	50
Lebanon	5	30	50	80	140	200
Malta	4	6	8	10	12	14
Morocco	5	10	13	20	60	140
Syria	0	0	0	1	2	5
Palestine	0	0	0	1	2	3
Tunisia	2.5	5	10	14	18	40
Turkey	120	200	400	700	1,100	1,400
SEMC	**414**	**669**	**1,075**	**1,665**	**2,398**	**3,292**

Source: ITU, World Atlas of Internet, IDATE

	Inhabitants (inhab.) 1997 (thousands)	Households (HH) 1996 (thousands)	Main lines (ML) 1997 (thousands)	ML per 100 inh. 1997 (%)	Digital ML on ML 1996 (%)	CaTV subscribers 1996 (thousands)	CaTV subscribers/ HH 1996 (%)	Cellular subscribers 100 inhab. 1997 (thousands)	Cellular subscribers/ 1997 (%)	Internet users 1997 (thousands)	Internet users/ 100 inhab. 1997 (%)
Algeria	30,585	4,172	1,376	4.5	45.9	0	0	8.9	0.0	1	0.0
Cyprus	742	208	379	51.1	79.4	0	0	94	12.7	8	1.1
Egypt	62,679	12,697	3,452	5.5	72.0	0	0	83.5	0.1	55	0.1
Israel	6,119	1,625	2,674	43.7	100.0	900	55.4	1,800	29.4	350	5.7
Jordan	4,199	750	386	9.2	70.6	0	0	50	1.2	4	0.1
Lebanon	2,891	600	550	19.0	99.0	1	0	291	10.1	30	1.0
Malta	376	125	185	49.2	100.0	52	41.6	18	4.8	6	1.6
Morocco	27,310	4,600	1,378	5.0	98.3	0	0	74.4	0.3	10	0.0
Syria	15,928	2,923	1,320	8.3	85.0	0	0	6	0.0	0	0.0
Palestine	2,008	400	110	5.5	n.a.	0	0	40	2.0	0	0.0
Tunisia	9,245	1,810	620	6.7	86.0	0	0	6.7	0.1	5	0.1
Turkey	64,238	13,446	15,786	24.6	78.4	483	3.6	1,614	2.5	200	0.3
SEMC	**226,320**	**43,356**	**28,216**	**12.5**	**n.a.**	**1,436**	**n.a.**	**4,086.5**	**1.8**	**669**	**0.3**

Table 7
SEMC ICT penetration

	1996	1997	1998	1999	2000	2001	1997/96 %	1998/97 %	1999/98 %	2000/99 %	2001/2000 %
Total server	53	58	64	70	77	85	10	10	10	10	10
Unix servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NT servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Server add-ons	7	8	9	9	10	12	12	11	11	11	11
Workstations	8	9	11	15	19	25	11	24	30	30	30
PCs	87	115	142	178	218	264	32	24	25	22	21
portable	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
desktop	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
PC/workstation add-ons	37	54	82	1115	155	218	49	50	40	35	41
PC printers	33	49	73	102	138	195	51	48	40	36	41
Other add-ons	4	5	9	13	16	23	31	71	39	29	39
Computer hardware	**185**	**236**	**299**	**376**	**475**	**598**	**28**	**27**	**26**	**26**	**26**
Copiers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other office equipment	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Office equipment	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
LAN hardware	1	1	1	1	1	1	33	13	22	9	17
Other data communications	0	1	1	1	1	1	20	17	14	25	20
Data communications hardware	**1**	**1**	**1**	**2**	**2**	**2**	**27**	**14**	**19**	**16**	**18**
IT hardware	**186**	**237**	**301**	**378**	**477**	**601**	**28**	**27**	**26**	**26**	**26**
Systems software	6	7	8	9	11	13	18	18	17	18	18
Application software	32	38	45	54	64	75	18	18	21	18	18
Software products	**38**	**44**	**53**	**63**	**74**	**88**	**18**	**18**	**20**	**18**	**18**
Consulting	21	25	30	37	45	54	22	22	20	22	20
Implementation	11	13	15	18	22	26	19	19	20	20	17
Operations management	13	15	18	22	26	30	20	20	19	20	17
Support services	25	30	35	42	49	60	18	18	18	18	22
Services	**69**	**83**	**99**	**118**	**142**	**170**	**20**	**20**	**19**	**20**	**20**
Software and services	**107**	**127**	**152**	**181**	**216**	**258**	**19**	**19**	**20**	**19**	**19**
Total IT market	**292**	**365**	**452**	**559**	**693**	**858**	**25**	**24**	**24**	**24**	**24**

Source : IDC

Table 8
Egypt, IT market value (million ECU)

	1996	1997	1998	1999	2000	2001	1997/96 %	1998/97 %	1999/98 %	2000/99 %	2001/2000 %
Total server	198	211	227	247	273	302	7	7	9	10	11
Unix servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NT servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Server add-ons	38	39	42	43	45	47	2	8	3	5	4
Workstations	107	118	129	148	168	191	10	10	14	14	14
PCs	362	364	355	375	391	407	0	– 3	6	4	4
portable	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
desktop	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
PC/workstation add-ons	125	134	146	161	180	198	8	9	10	12	10
PC printers	97	105	114	124	138	151	7	9	9	11	10
Other add-ons	27	30	33	37	42	47	8	11	13	14	11
Computer hardware	**791**	**827**	**857**	**931**	**1,012**	**1,099**	**5**	**4**	**9**	**9**	**9**
Copiers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other office equipment	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Office equipment	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
LAN hardware	90	99	113	128	145	165	10	14	13	13	13
Other data communications	75	88	99	109	121	135	17	13	10	11	11
Data communications hardware	**165**	**187**	**212**	**238**	**267**	**299**	**13**	**14**	**12**	**12**	**12**
IT hardware	**956**	**1,014**	**1,070**	**1,169**	**1,278**	**1,398**	**6**	**6**	**9**	**9**	**9**
Systems software	97	108	118	131	142	155	11	10	10	9	9
Application software	255	291	308	334	365	398	14	6	8	9	9
Software products	**352**	**399**	**427**	**465**	**507**	**552**	**13**	**7**	**9**	**9**	**9**
Consulting	110	138	170	191	221	249	25	23	12	16	13
Implementation	194	225	282	319	355	395	16	25	13	11	11
Operations management	135	164	229	259	292	337	22	39	13	13	15
Support services	126	147	176	199	225	254	16	20	13	13	13
Services	**565**	**673**	**857**	**968**	**1093**	**1236**	**19**	**27**	**13**	**13**	**13**
Software and services	**917**	**1,072**	**1,283**	**1,433**	**1,600**	**1,788**	**17**	**20**	**12**	**12**	**12**
Total IT market	**1,874**	**2,086**	**2,353**	**2,612**	**2,899**	**3,189**	**11**	**13**	**11**	**11**	**10**

Table 9
Israel, IT market value
(million ECU)

Source : IDC

	1996	1997	1998	1999	2000	2001	1997/96 %	1998/97 %	1999/98 %	2000/99 %	2001/2000 %
Total server	151	178	185	250	336	453	18	4	35	35	35
Unix servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NT servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other servers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Server add-ons	17	20	20	24	29	35	17	2	20	20	20
Workstations	11	12	14	16	18	20	4	14	15	14	14
PCs	272	340	459	535	625	706	25	35	17	17	13
portable	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
desktop	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
PC/workstation add-ons	74	103	136	146	163	188	39	31	8	12	15
PC printers	64	87	118	126	140	161	36	36	6	12	15
Other add-ons	11	17	18	20	23	26	57	6	15	12	15
Computer hardware	**509**	**633**	**793**	**947**	**1,142**	**1,367**	**24**	**25**	**19**	**21**	**20**
Copiers	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other office equipment	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Office equipment	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
LAN hardware	80	130	164	196	262	340	62	26	20	33	30
Other data communications	5	7	8	10	13	16	33	28	23	25	25
Data communications hardware	**85**	**136**	**172**	**207**	**275**	**356**	**61**	**26**	**20**	**33**	**30**
IT hardware	**593**	**769**	**965**	**1,154**	**1,417**	**1,723**	**30**	**25**	**20**	**23**	**22**
Systems software	31	36	42	53	66	82	14	18	25	25	25
Application software	71	93	122	158	214	287	30	32	30	35	34
Software products	**103**	**128**	**164**	**211**	**280**	**369**	**25**	**28**	**29**	**33**	**32**
Consulting	9	14	20	29	44	67	64	40	50	50	51
Implementation	28	43	62	87	121	170	55	45	40	40	40
Operations management	30	43	58	75	104	129	43	36	29	39	25
Support services	49	69	91	120	158	209	41	30	32	32	32
Services	**115**	**169**	**230**	**311**	**427**	**575**	**46**	**36**	**35**	**38**	**34**
Software and services	**218**	**297**	**394**	**521**	**707**	**944**	**36**	**33**	**32**	**36**	**33**
Total IT market	**811**	**1,067**	**1,359**	**1,675**	**2,124**	**2,667**	**31**	**27**	**23**	**27**	**26**

Source : IDC

Table 10
Turkey, IT market value (million ECU)

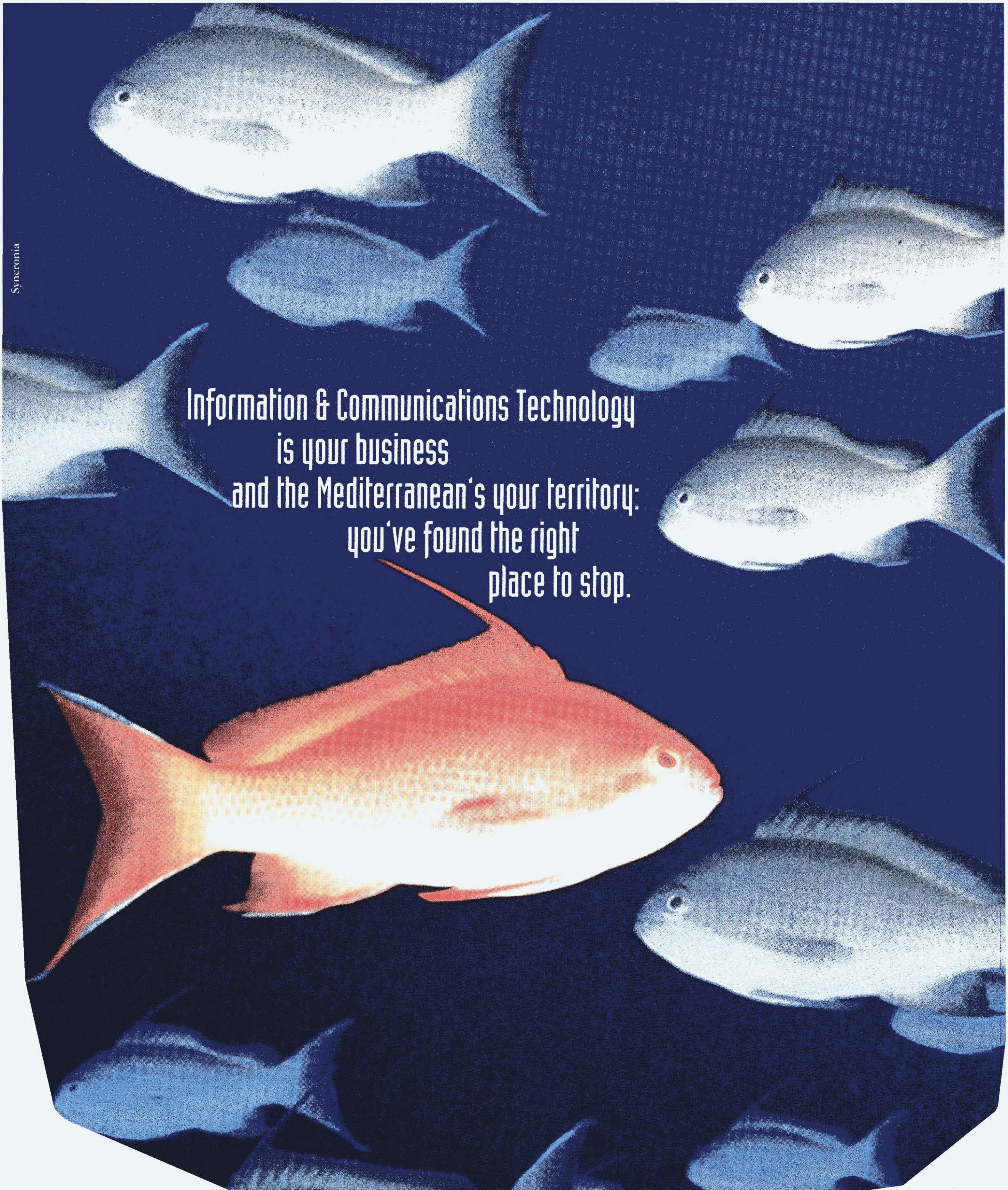
Table11
Turkey, IT hardware shipments (units)

	1996	1997	1998	1999	2000
Total servers	4,230	9,561	12,762	16,845	21,200
Unix servers	n.a.	n.a.	n.a.	n.a.	n.a.
NT servers	n.a.	n.a.	n.a.	n.a.	n.a.
Other servers	n.a.	n.a.	n.a.	n.a.	n.a.
Workstations	1,500	2,400	3,168	4,900	8,100
PCs	240,478	346,620	469,000	62,900	850,000
portable	7,497	12,596	16,615	28,305	42,500
desktop	232,981	334,024	449,300	609,300	807,500
PC printers	113,500	182,000	280,000	410,000	540,000
Typewriters	n.a.	n.a.	n.a.	n.a.	n.a.
Calculators	n.a.	n.a.	n.a.	n.a.	n.a.
Copiers	n.a.	n.a.	n.a.	n.a.	n.a.
LAN cards	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Interpro

Table 12
SEMC telecommunications market, 1997 (million ECU)

	1996 Morocco	1997 Turkey	1998 Israel	1999 Egypt	2000 Cyprus
Switching	n.a.	n.a.	n.a.	n.a.	n.a.
Transmission	n.a.	n.a.	n.a.	n.a.	n.a.
Mobile communication infrastructure	n.a.	n.a.	n.a.	n.a.	n.a.
Public network equipment	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
PABX and key systems	n.a.	n.a.	n.a.	n.a.	n.a.
Telephone sets	n.a.	n.a.	n.a.	n.a.	n.a.
Mobile terminal equipment	n.a.	n.a.	n.a.	n.a.	n.a.
Other terminal equipment	n.a.	n.a.	n.a.	n.a.	n.a.
Private network equipment	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
Telecom Equipment	**261**	**1,080**	**1,180**	**834**	**n.a.**
Telephone services	n.a.	n.a.	1,633	n.a.	n.a.
Mobile telephone services	n.a.	n.a.	807	n.a.	n.a.
Switched data and leased lines services					
CATV services	n.a.	n.a.	90	n.a.	n.a.
CaTV services	n.a.	n.a.	n.a.	n.a.	n.a.
Telecom services	**592**	**2,150**	**2,530**	**676**	**218**
Total telecom	**853**	**3,230**	**3,710**	**1,510**	**n.a.**
Source	**IAM 1997**	**Turk Telekom 1997**	**Bezeq 1997**	**Egypt Telecom 1997**	**CYTA 1996**


Information & Communications Technology
is your business
and the Mediterranean's your territory:
you've found the right
place to stop.
Syncronia

Part Three

Statistical outlook

The data and forecasts presented in the statistical outlook have been jointly prepared by IDC and the EITO Task Force on the basis of the latest information available as of end of November 1998.

ICT market size and growth trends by country and technology reflect the opinion of both the EITO Task Force and IDC. The data and trends in the Statistical outlook are the result of the overall statistical framework provided by IDC, and the considerations and assumptions by the EITO Task Force.

It should be noted that all figures have been rounded at 1997 constant exchange rates. Totals and percentages may not add up due to rounding.

1. Introduction

Part Three presents statistics which illustrate the shape and structures behind the IT and communications markets in Europe. The subject is presented in three main sub-sections:

- the shape of the various national ICT markets, within an international context, and the patterns of trade between them;
- the individual market structures with an eye to the competitive aspects, as well as comparative measures of ICT penetration;
- the role of technological advancement in altering the underlying economics of ICT.

Terms are defined at the end of Part Three.

2. Methodology

The following analysis attempts to shed light on some of the more important aspects of the European markets for telecommunications and information technology products, including substantial elements of the associated market for office automation products.

The basis for the study is the marketplace; the results are expressed in end-user spending. Valuation is largely based upon the performance of primary vendors, with research results cross-checked against a continuous programme of end-user interviews and distribution channel monitoring. Data on trade flows has also been collected, and matched as closely as possible to market-oriented segmentation, since these data can provide information relating to the position of Europe with respect to the world. What is presented then, is a comprehensive body of data which aims to illuminate the European ICT market.

The adaptation of some new IDC research methodologies has led to the restatement of some current and historical sizes and growth trends. These have occurred either because of the availability of better research evidence to justify the new sizing, or because of changes in the markets researched.

The recent most significant changes were related to the server market, with the adoption of a classification based on operating system platforms, and on the services market.

Historical reconciliation is still admissible at the macro-category level, although a change in the perimeter of the services market needs to be considered. This change is due to the shift of the "network services" category from services under the IT section, in the past editions, to switched data and leased line service (within which segment it is not itemised) under the telecommunication section.

A detailed description of the market segments is available under "*Definitions*" at the end of Part Three.

3. European ICT markets and patterns of trade

All forecast data are prepared in local currencies and subsequently at 1997 exchange rates of those currencies against the ECU for all the years of the historical and the forecast period. Growth rates therefore correspond to local currency growth rates. No adjustment is made for the effects of inflation. Trade data are reported in current ECU, according to the standard reporting conventions.

In terms of classes of product, again a full definition account appears later in this volume. Here we note that the definition of the hardware marketplace has been expanded beyond the traditional IT systems arena, to include a broad category of office hardware technologies such as photocopiers, typewriters and calculating machines, and tele- and data communications equipment and services.

The heading EU refers to Austria, Belgium and Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Spain, Sweden, Portugal, the UK. The sole exception is Part 8 (ICT trade flows) where definitions of the EU are governed by the methodology of Eurostat. Non-EU is represented by data on Norway and Switzerland. Western Europe figures are the sum of EU countries plus Norway and Switzerland. Central and Eastern Europe is considered to refer to the Czech Republic, Hungary, Poland, Russia, Slovakia, Slovenia and Estonia. Eastern Europe also includes the following countries in aggregate format: Bulgaria, Romania, Ukraina, Croazia, Former Yugoslavia, Albania, Latvia, Lithuania.

4. List of tables

5. List of figures

Economic background, 1982-2000

International ICT markets

Price dynamics

6. Economic background

Table 1
Real GDP growth in %, 1992–2000

	1992	1993	1994	1995	1996	1997	1998*	1999*	2000*
Austria	1.3	0.5	2.5	2.1	1.6	2.5	3.1	2.4	2.6
Belgium	1.5	-1.5	2.4	2.1	1.5	3.0	2.9	2.3	2.3
Denmark	1.3	1.3	3.5	3.1	3.4	3.3	2.4	2.0	1.9
Finland	-3.6	-1.2	4.5	5.1	3.3	6.1	5.0	3.2	3.0
France	1.2	-1.3	2.8	2.1	1.5	2.3	3.1	2.4	2.6
Germany	2.2	-1.2	2.7	1.8	1.4	2.2	2.7	2.2	2.5
Greece	0.7	-1.6	1.7	1.8	2.6	3.2	3.0	3.2	3.4
Ireland	3.7	2.9	6.3	9.8	7.9	9.8	9.1	6.7	6.5
Italy	0.6	-1.2	2.2	2.9	0.7	1.5	1.5	2.1	2.6
Netherlands	2.0	0.8	3.2	2.3	3.3	3.6	3.8	2.7	2.5
Norway	3.3	2.7	5.5	3.6	5.3	3.4	2.3	2.3	1.8
Portugal	1.8	0.3	0.7	1.9	3.0	3.7	4.0	3.3	3.2
Spain	0.7	-1.2	2.2	2.7	2.3	3.5	3.8	3.4	3.4
Sweden	-1.4	-2.2	3.3	3.9	1.3	1.8	2.8	2.2	2.4
Switzerland	0.1	-0.5	0.5	0.8	-0.2	1.7	1.7	1.6	1.8
United Kingdom	-0.5	2.1	4.3	2.7	2.3	3.5	2.7	0.8	1.5
European Union	1.0	-0.5	2.9	2.5	1.7	2.7	2.8	2.2	2.5
USA	2.7	2.3	3.5	2.0	2.8	3.9	3.5	1.5	2.2
Japan	1.0	0.3	0.6	1.4	3.5	0.8	-2.6	0.2	0.7

Source: OECD, December 1998 * Estimates and projections

Table 2
Nominal GDP growth in %, 1992–2000

	1992	1993	1994	1995	1996	1997	1998*	1999*	2000*
Austria	5.7	3.3	5.4	4.2	3.8	3.9	4.1	3.7	4.0
Belgium	5.2	2.6	4.8	3.8	3.1	4.5	4.2	3.7	3.7
Denmark	3.5	2.1	6.1	5.2	5.4	5.3	4.1	4.7	5.2
Finland	-2.9	1.2	5.9	7.6	4.5	7.3	8.4	4.8	5.7
France	3.3	1.1	4.4	3.7	2.8	3.3	3.9	3.5	3.9
Germany	7.9	2.8	5.2	3.9	2.4	2.9	3.9	3.5	3.9
Greece	15.7	12.6	13.2	11.1	11.3	10.3	7.7	6.4	6.3
Ireland	6.2	7.5	8.2	10.9	9.1	12.3	13.3	9.8	9.6
Italy	5.3	3.2	5.7	8.1	5.8	4.2	4.2	4.1	4.1
Netherlands	4.3	2.7	5.6	3.9	4.6	5.9	5.8	4.9	4.8
Norway	2.8	4.9	5.3	7.1	9.6	6.4	0.9	4.3	4.7
Portugal	12.6	6.3	6.6	7.0	6.4	6.6	6.8	6.1	5.7
Spain	7.6	3.1	6.3	7.7	5.5	5.6	6.5	5.9	5.9
Sweden	-0.4	0.3	5.9	7.8	2.3	3.0	4.0	3.4	4.2
Switzerland	2.6	2.2	2.1	2.1	-0.2	1.6	2.5	3.0	3.0
UK	4.0	5.4	6.0	5.2	5.4	6.3	5.0	3.9	4.1
European Union	5.5	3.2	5.6	5.5	4.2	4.5	4.7	4.1	4.3
USA	5.5	5.0	5.9	4.6	5.1	5.9	4.5	2.7	4.0
Japan	2.8	0.9	0.8	0.8	3.6	1.4	-1.9	-0.2	0.2

Source: OECD, December 1998 * Estimates and projections

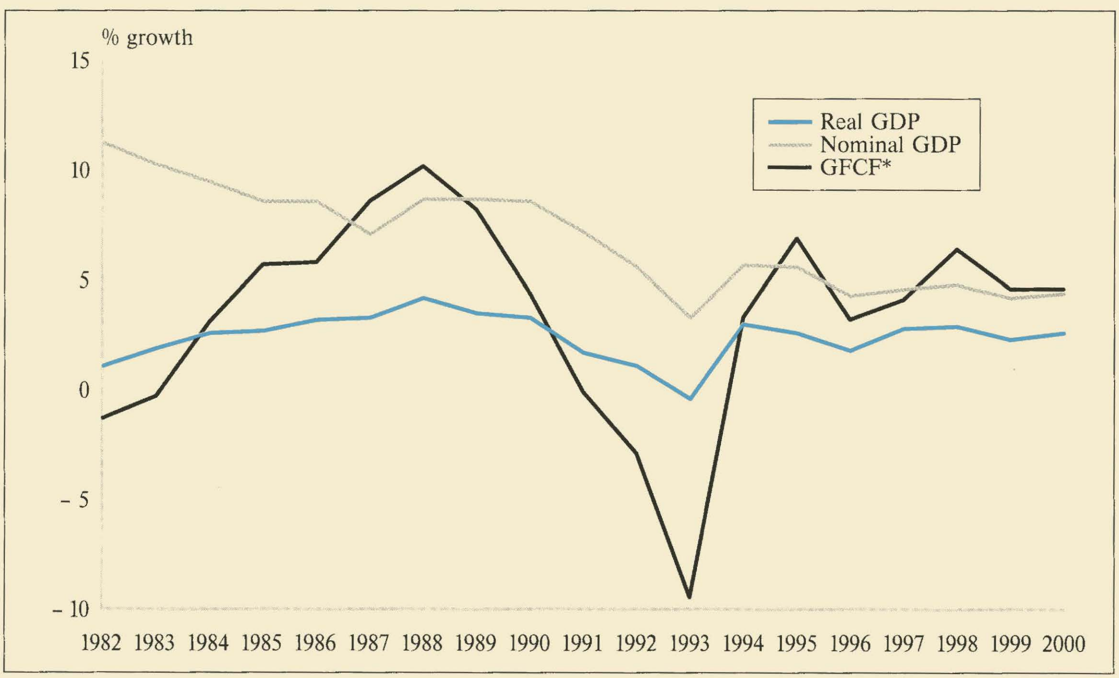
Table 3
Real gross private non-residential fixed capital formation, growth in %, 1992-2000

	1992	1993	1994	1995	1996	1997	1998*	1999*	2000*
Austria	- 2.2	- 5.5	10.1	3.7	3.3	7.9	7.5	4.4	5.3
Belgium	- 0.9	- 6.7	-3.4	5.1	4.7	4.2	5.3	4.1	3.8
Denmark	- 3.8	1.5	-1.4	16.8	7.1	12.0	6.1	4.3	4.0
Finland	-21.3	-22.6	2.3	25.1	12.1	7.6	7.4	9.2	6.9
France	- 4.0	- 8.2	1.5	3.5	-0.4	0.3	6.8	5.6	5.0
Germany	0.0	-10.2	0.6	0.9	-0.8	2.1	5.0	4.1	5.2
Greece	2.3	1.0	2.3	8.2	10.2	10.0	8.0	8.7	9.8
Ireland	- 6.5	- 4.1	3.9	9.6	21.5	11.9	10.8	7.8	7.8
Italy	- 1.2	-18.5	5.1	13.5	1.9	1.7	2.5	3.2	3.7
Netherlands	- 3.0	- 4.2	0.3	7.4	9.2	8.1	3.5	4.0	3.5
Norway	8.3	22.4	17.4	15.3	3.7	13.4	6.5	-8.1	-6.4
Portugal	5.4	- 4.8	3.5	7.5	8.0	n.a.	n.a.	n.a.	n.a.
Spain	2.0	15.0	4.0	12.2	5.2	6.8	10.5	8.7	9.2
Sweden	-15.5	-13.0	18.6	27.7	4.7	-0.1	10.5	7.0	5.0
Switzerland	-11.6	- 8.6	1.4	9.8	-2.9	4.3	5.5	4.7	4.1
UK	- 6.2	- 1.4	5.5	3.9	8.3	8.8	9.3	1.6	0.9
European Union	- 3.0	- 9.6	3.2	6.8	3.1	4.0	6.3	4.5	4.5
USA	1.9	7.6	8.0	9.0	9.2	10.7	10.9	1.1	2.5
Japan	- 5.6	-10.2	-5.3	3.9	6.6	4.3	-9.6	-4.1	-0.3

Source: OECD, December 1998

* Estimates and projections

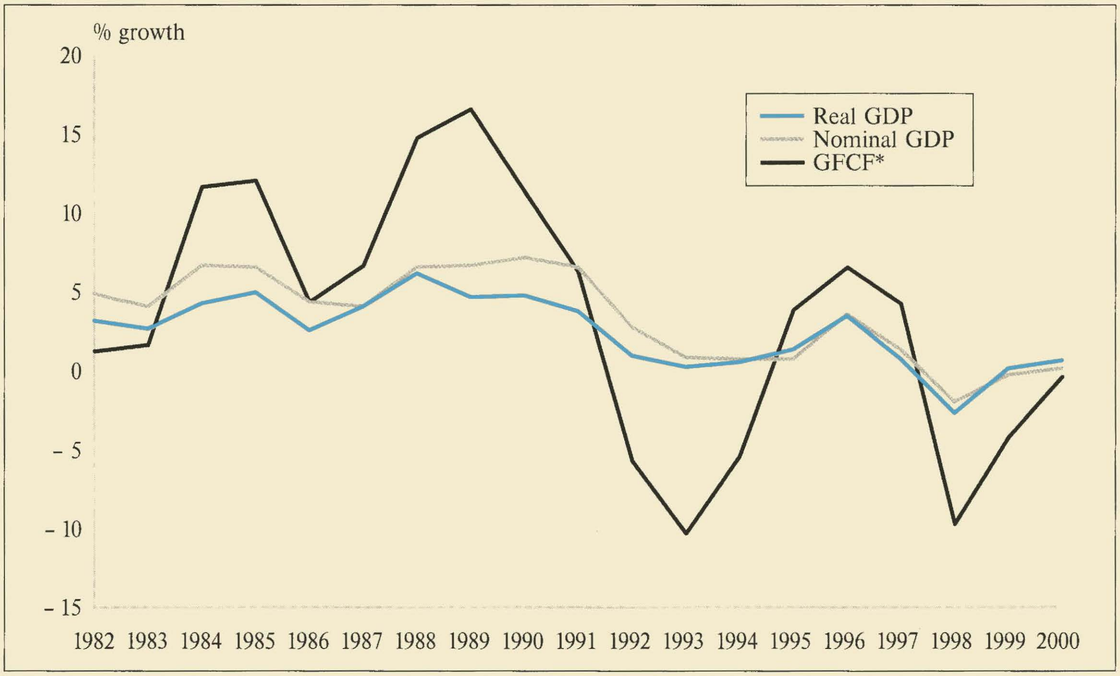
Figure 1
Economic developments in the European Union, 1982-2000



Source: OECD

* GFCF - Gross Fixed Capital Formation

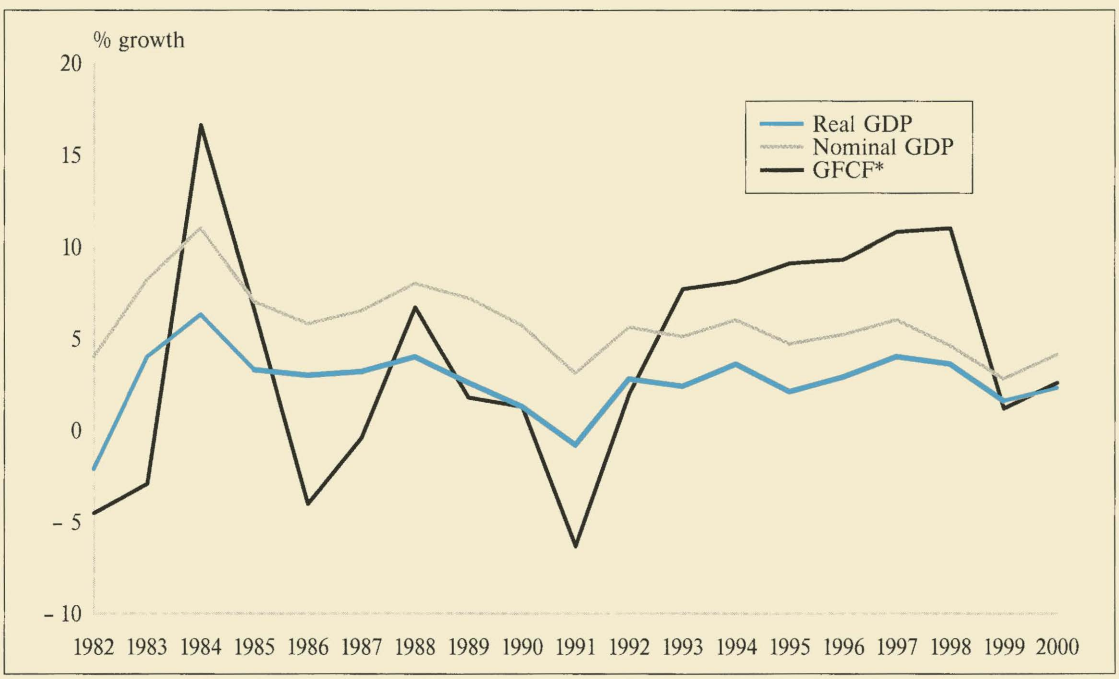
Figure 2
Economic developments in Japan, 1982–2000



Source: OECD

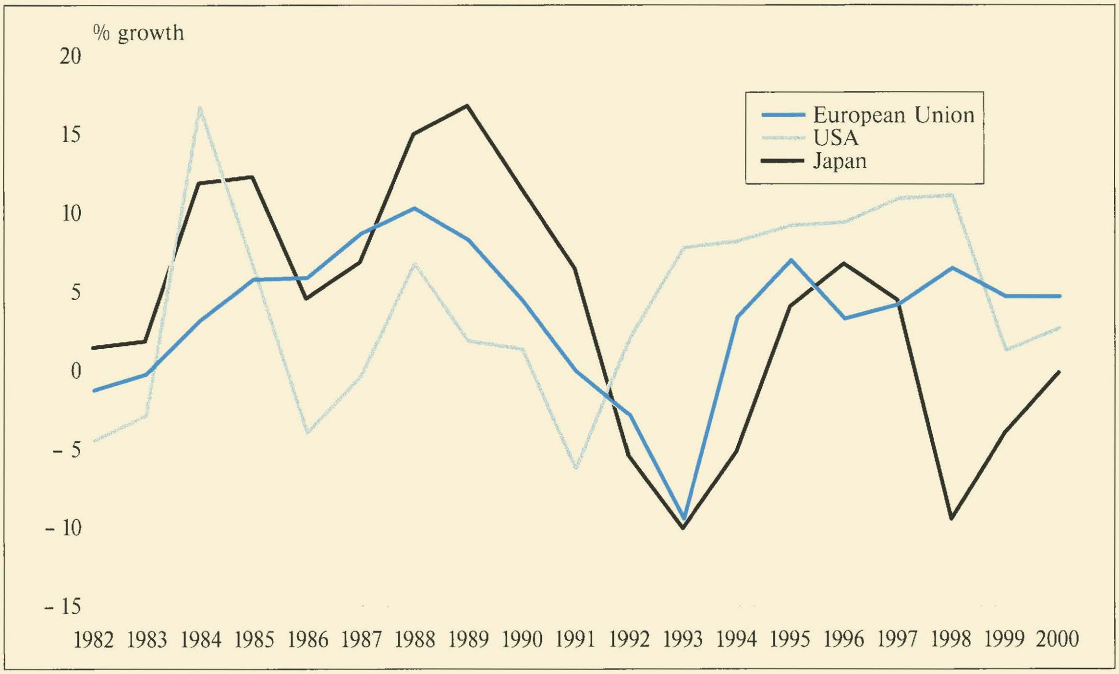
* GFCF – Gross Fixed Capital Formation

Figure 3
Economic developments in the USA, 1982–2000



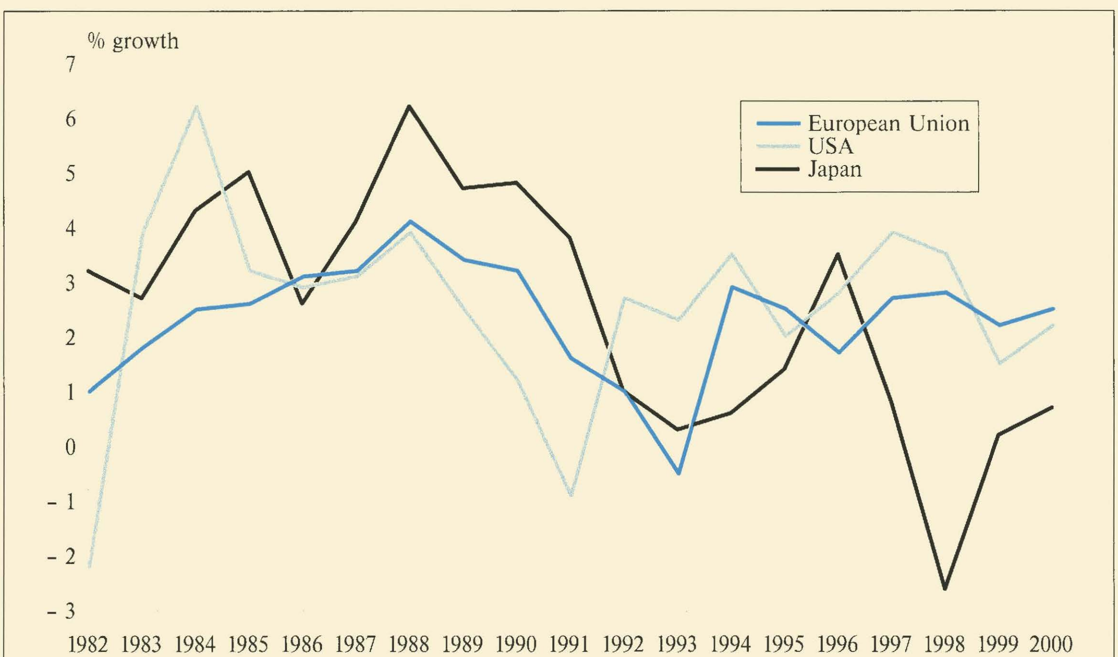
Source: OECD

* GFCF – Gross Fixed Capital Formation



Source: OECD

Figure 4
Growth of gross private non-residential fixed capital formation in the European Union, the USA and Japan, 1982–2000

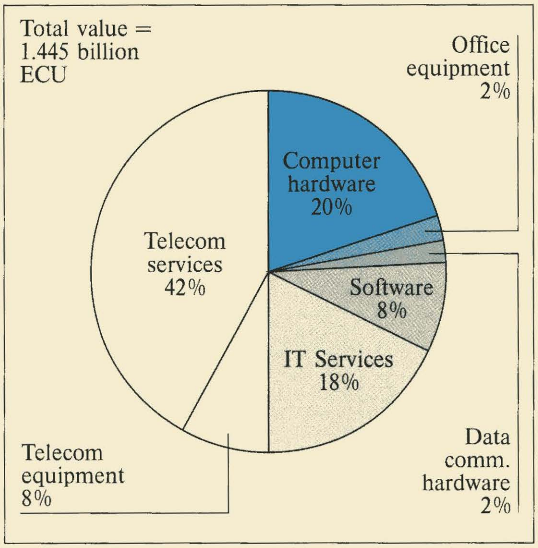


Source: OECD

Figure 5
Growth of real gross domestic product in the European Union, the USA and Japan, 1982–2000

7. International ICT markets

Figure 6
Worldwide ICT market by product, 1998



Source: EITO

Million ECU	1995	1996	1997	1998	1999	2000
Europe (incl. Eastern Europe)	158,242	174,908	190,874	206,647	225,831	247,793
US	233,679	262,421	291,313	319,279	347,057	378,292
Japan	81,448	89,953	94,813	91,027	95,677	102,523
Rest of World	70,069	81,842	95,488	110,006	121,805	138,333
Total	**543,438**	**609,124**	**672,488**	**726,960**	**790,369**	**866,941**
	% growth					
Europe (incl. Eastern Europe)	8.1	10.5	9.1	8.3	9.3	9.7
US	14.3	12.3	11.0	9.6	8.7	9.0
Japan	9.3	10.4	5.4	-4.0	5.1	7.2
Rest of World	18.3	16.8	16.7	15.2	10.7	13.6
Total	**12.0**	**12.1**	**10.4**	**8.1**	**8.7**	**9.7**
	% breakdown					
Europe (incl. Eastern Europe)	29.1	28.7	28.4	28.4	28.6	28.6
US	43.0	43.1	43.3	43.9	43.9	43.6
Japan	15.0	14.8	14.1	12.5	12.1	11.8
Rest of World	12.9	13.4	14.2	15.1	15.4	16.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 4
*Worldwide IT market growth trends. Market value. Million ECU at constant 1997 exchange rates**

* See Definitions 11.3.6. exchange rates

Million ECU	1995	1996	1997	1998	1999	2000
Europe (incl. Eastern Europe)	180,489	197,339	214,425	230,305	244,597	261,470
US	164,493	175,097	185,445	198,284	211,172	224,476
Japan	69,477	72,546	75,207	73,256	76,333	80,302
Rest of World	157,503	176,334	196,102	216,104	239,660	263,147
Total	**571,962**	**621,315**	**671,179**	**717,950**	**771,762**	**829,395**
	% growth					
Europe (incl. Eastern Europe)	8.8	9.3	8.7	7.4	6.2	6.9
US	4.9	6.4	5.9	6.9	6.5	6.3
Japan	5.0	4.4	3.7	-2.6	4.2	5.2
Rest of World	11.8	12.0	11.2	10.2	10.9	9.8
Total	**7.9**	**8.6**	**8.0**	**7.0**	**7.5**	**7.5**
	% breakdown					
Europe (incl. Eastern Europe)	31.6	31.8	31.9	32.1	31.7	31.5
US	28.8	28.2	27.6	27.6	27.4	27.1
Japan	12.1	11.7	11.2	10.2	9.9	9.7
Rest of World	27.5	28.4	29.2	30.1	31.1	31.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5
*Worldwide telecommunications market growth trends. Market value. Million ECU at constant 1997 exchange rates**

* See Definitions 11.3.6. exchange rates

Table 6
*Worldwide ICT market growth trends. Market value. Million ECU at constant 1997 exchange rates**

Million ECU	1995	1996	1997	1998	1999	2000
Europe (incl. Eastern Europe)	338,731	372,247	405,300	436,952	470,427	509,263
US	398,172	437,518	476,758	517,563	558,229	602,768
Japan	150,924	162,498	170,020	164,284	172,010	182,826
Rest of World	227,572	258,176	291,590	326,110	361,465	401,480
Total	**1,115,399**	**1,230,439**	**1,343,667**	**1,444,910**	**1,562,131**	**1,696,336**
	% growth					
Europe (incl. Eastern Europe)	8.5	9.9	8.9	7.8	7.7	8.3
US	10.2	9.9	9.0	8.6	7.9	8.0
Japan	7.3	7.7	4.6	-3.4	4.7	6.3
Rest of World	13.8	13.4	12.9	11.8	10.8	11.1
Total	**9.9**	**10.3**	**9.2**	**7.5**	**8.1**	**8.6**
	% breakdown					
Europe (incl. Eastern Europe)	30.4	30.3	30.2	30.2	30.1	30.0
US	35.7	35.6	35.5	35.8	35.7	35.5
Japan	13.5	13.2	12.7	11.4	11.0	10.8
Rest of World	20.4	21.0	21.7	22.6	23.1	23.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

* See Definitions 11.3.6. exchange rates

1998	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT hardware	86,752	8,940	141,581	43,759	65,000	346,033
Software	38,261	1,546	54,976	10,358	14,807	119,948
IT services	68,031	3,117	122,722	36,910	30,199	260,978
Telecom equipment	33,456	12,107	22,116	11,528	39,658	118,865
Telecom services	165,630	19,113	176,168	61,729	176,446	599,085
Total	**392,129**	**44,823**	**517,563**	**164,284**	**326,110**	**1,444,910**
2000	**Western Europe**	**Eastern Europe**	**US**	**Japan**	**Rest of World**	**World**
IT hardware	96,809	10,084	157,394	47,530	71,371	383,188
Software	48,463	1,872	72,213	12,971	17,930	153,449
IT services	86,695	3,870	148,685	42,022	49,033	330,305
Telecom equipment	37,709	13,499	23,346	11,885	44,606	131,044
Telecom services	186,442	23,820	201,131	68,418	218,541	698,351
Total	**456,118**	**53,144**	**602,768**	**182,826**	**401,480**	**1,696,336**

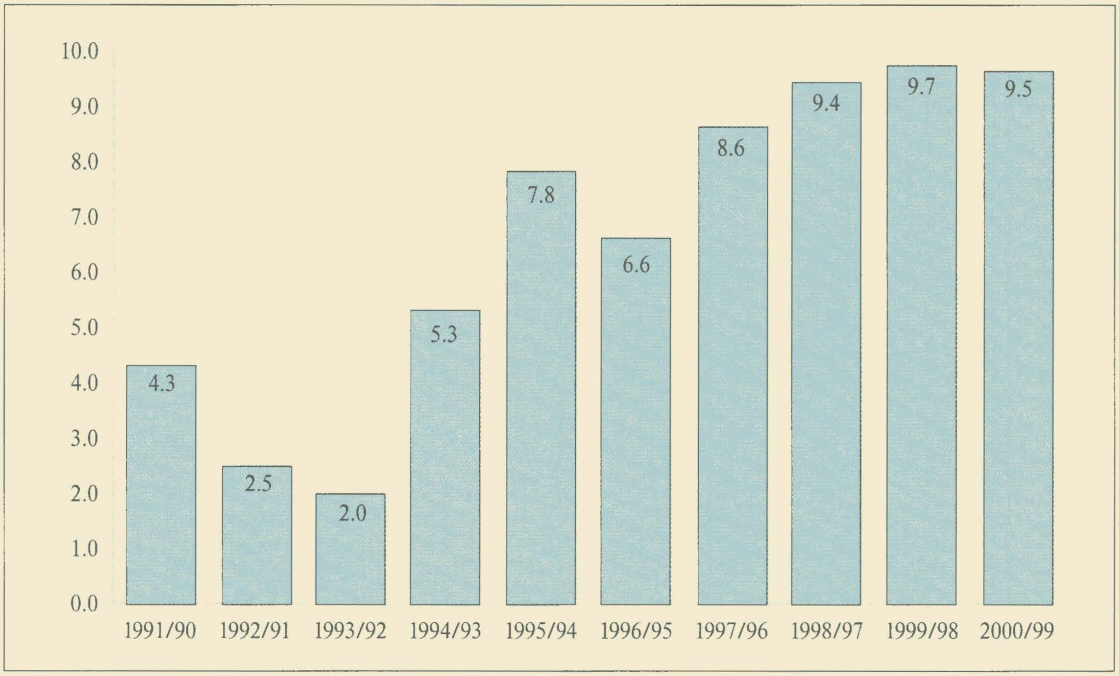
Table 7
*Major regional ICT markets by product, 1998 and 2000. Million ECU at constant 1997 exchange rates**

* See Definitions 11.3.6. exchange rates

	Western Europe	Eastern Europe	US	Japan	Rest of World	World
IT hardware	5.6	6.2	5.4	4.2	4.8	5.2
Software	12.5	10.0	14.6	11.9	10.0	13.1
IT services	12.9	11.4	10.1	6.7	27.4	12.5
IT	9.6	7.9	8.8	6.1	12.1	9.2
Telecom equipment	6.2	5.6	2.7	1.5	6.1	5.0
Telecom services	6.1	11.6	6.9	5.3	11.3	8.0
Telecom	6.1	9.3	6.4	4.7	10.3	7.5
Total	**7.9**	**8.9**	**7.9**	**5.5**	**11.0**	**8.4**

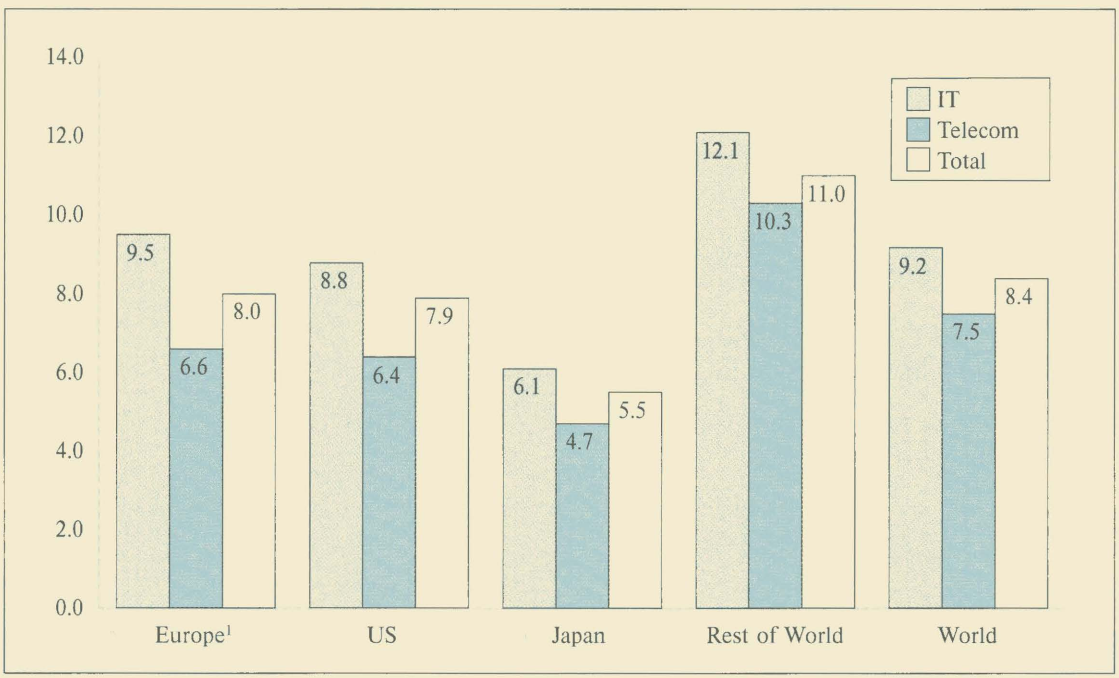
Table 8
Major regional ICT markets by product. % average annual growth by value, 1998–2000

Figure 7
Western European IT market growth rates in %, 1991–2000



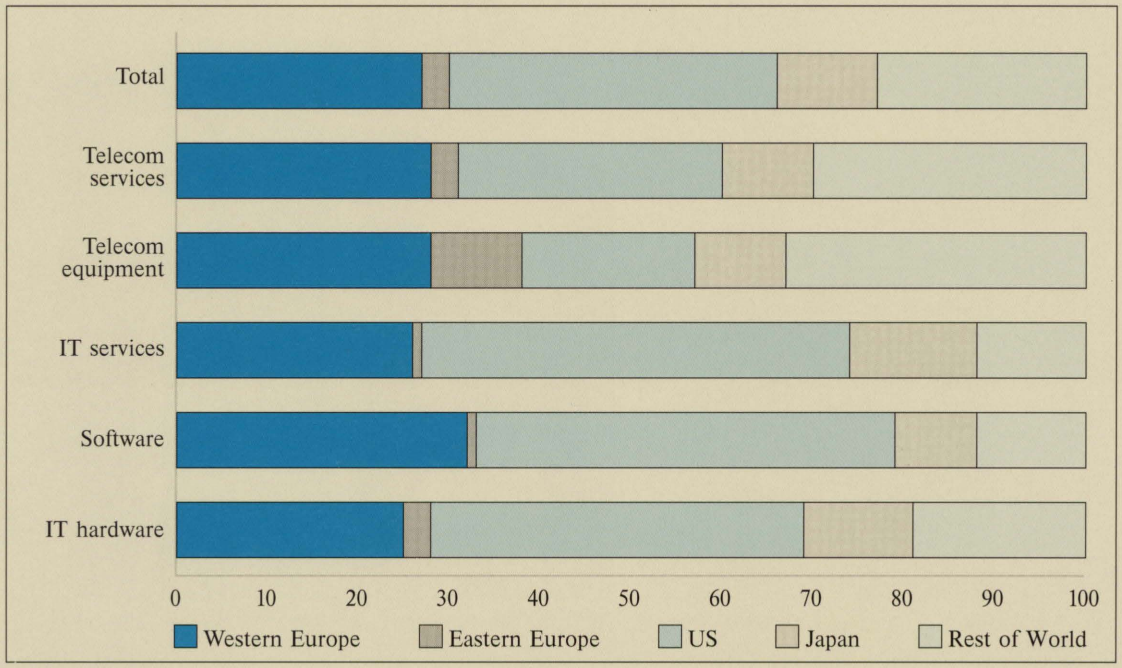
Source: EITO

Figure 8
World annual ICT markets average annual growth in %, 1998–2000



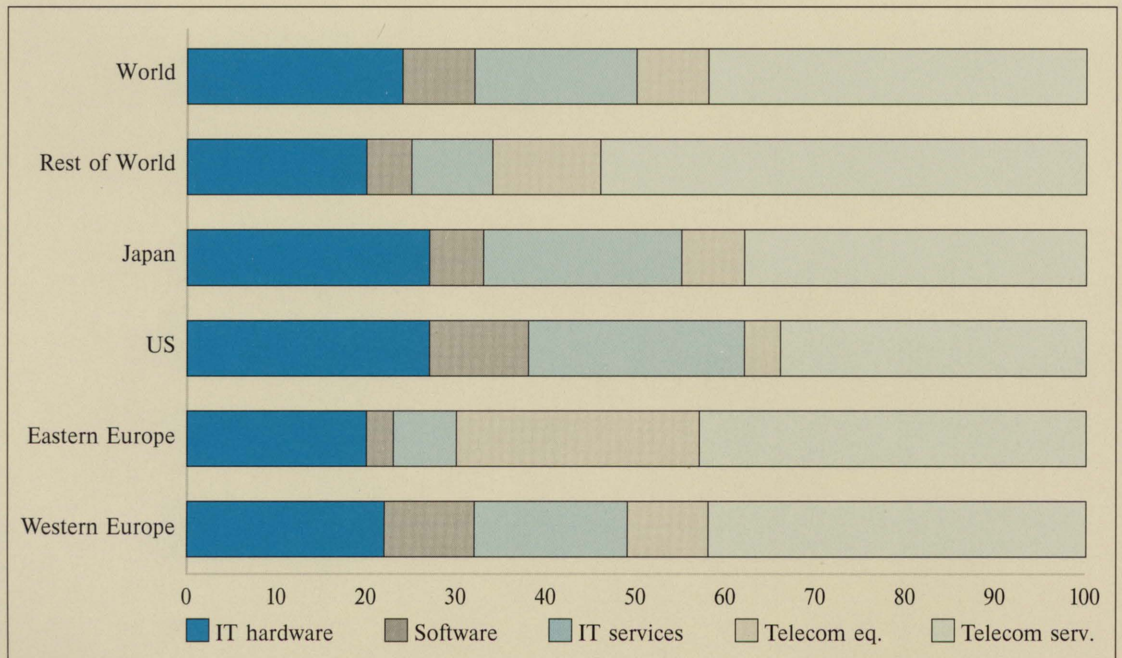
[1] Eastern and Western Europe

Source: EITO



Source: EITO

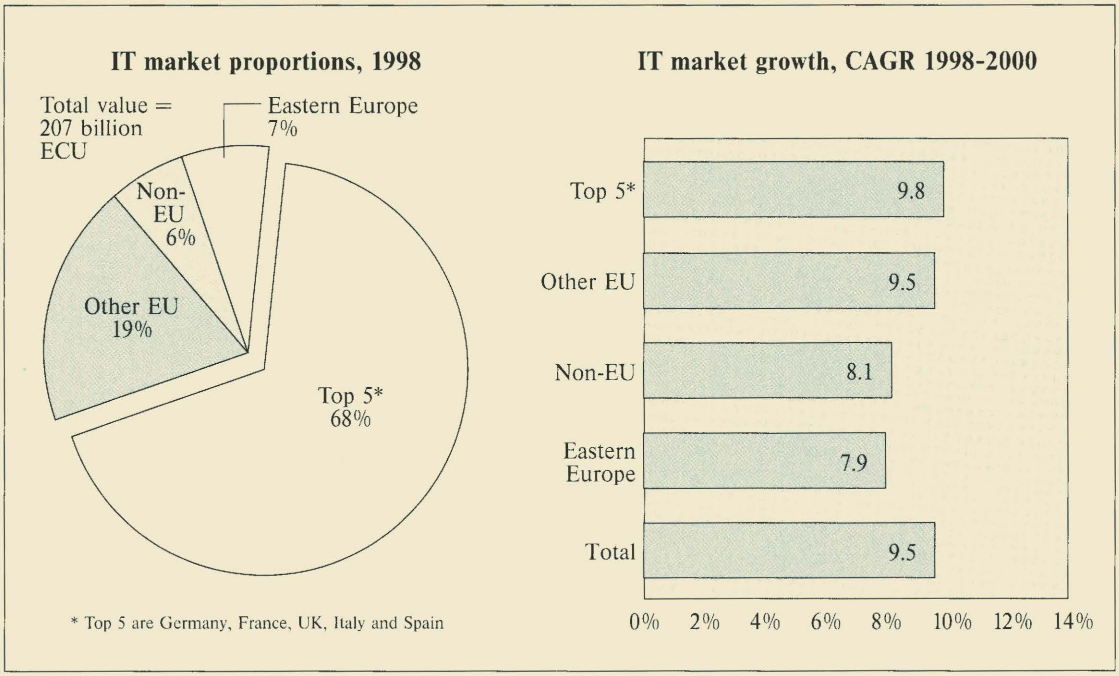
Figure 9
World ICT market regional proportions by product in %, 1998



Source: EITO

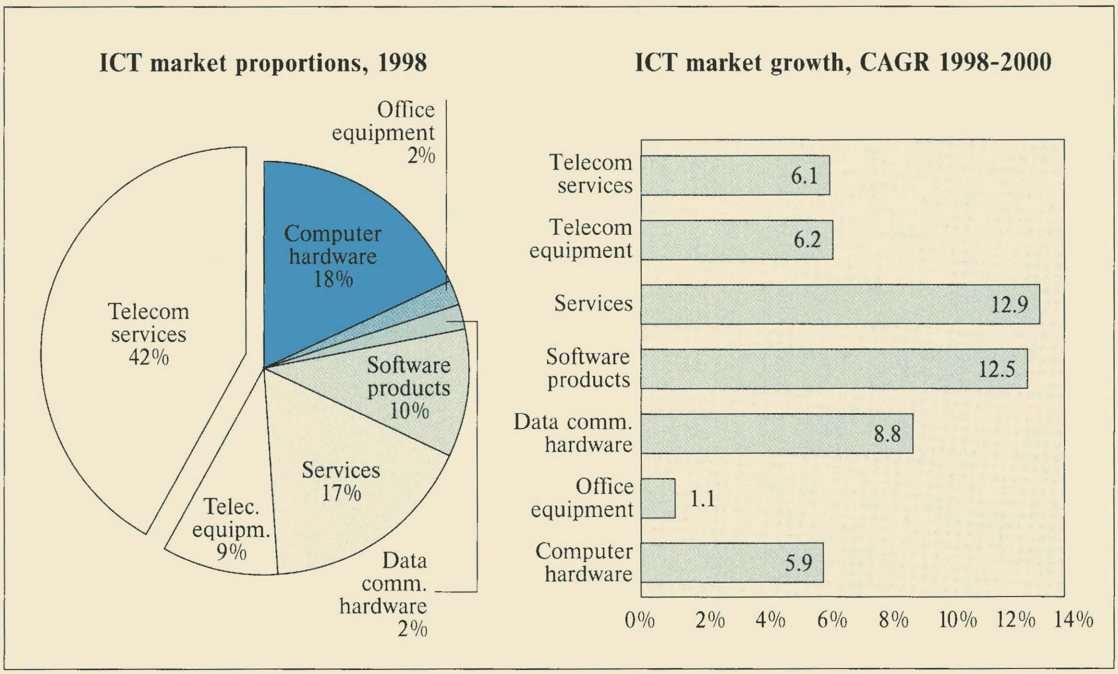
Figure 10
World ICT market product proportions by region in %, 1998

Figure 11
European IT market by region, 1998 and market growth, 1998–2000



Source: EITO

Figure 12
Western European ICT market, proportions by class of business, 1998 and market growth, 1998–2000



Source: EITO

Table 9
IT market by country, million ECU

Western Europe	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Austria	3,443	3,773	4,106	4,470	4,827	9.6	8.8	8.9	8.0
Belgium/Luxembourg	4,540	5,032	5,541	6,117	6,621	10.8	10.1	10.4	8.2
Denmark	3,857	4,211	4,556	4,917	5,372	9.2	8.2	7.9	9.2
Finland	2,427	2,688	2,946	3,251	3,565	10.8	9.6	10.4	9.7
France	28,729	31,118	34,167	37,616	41,669	8.3	9.8	10.1	10.8
Germany	38,105	40,993	44,874	49,380	53,990	7.6	9.5	10.0	9.3
Greece	794	889	992	1,119	1,245	11.9	11.7	12.7	11.3
Ireland	1,081	1,189	1,312	1,456	1,598	10.0	10.3	11.0	9.8
Italy	14,193	15,093	16,340	17,702	19,248	6.3	8.3	8.3	8.7
Netherlands	8,254	9,113	9,933	10,882	11,860	10.4	9.0	9.6	9.0
Norway	3,126	3,437	3,742	4,073	4,440	9.9	8.9	8.8	9.0
Portugal	1,131	1,263	1,383	1,514	1,666	11.6	9.5	9.4	10.1
Spain	6,000	6,630	7,261	7,946	8,728	10.5	9.5	9.4	9.8
Sweden	6,517	6,990	7,703	8,543	9,341	7.3	10.2	10.9	9.3
Switzerland	6,818	7,267	7,743	8,412	8,985	6.6	6.5	8.6	6.8
UK	33,536	36,820	40,442	44,422	48,812	9.8	9.8	9.8	9.9
Western Europe	162,553	176,506	193,044	211,820	231,967	8.6	9.4	9.7	9.5

Table 10
Telecommunications market by country, million ECU

Western Europe	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Austria	3,376	3,731	4,061	4,349	4,619	10.5	8.9	7.1	6.2
Belgium/Luxembourg	4,712	5,173	5,654	6,088	6,503	9.8	9.3	7.7	6.8
Denmark	3,154	3,411	3,605	3,814	4,051	8.1	5.7	5.8	6.2
Finland	2,421	2,612	2,862	3,068	3,258	7.9	9.6	7.2	6.2
France	25,245	27,478	30,206	32,102	33,869	8.8	9.9	6.3	5.5
Germany	39,677	41,874	44,166	46,134	47,982	5.5	5.5	4.5	4.0
Greece	2,806	3,263	3,837	4,282	4,623	16.3	17.6	11.6	8.0
Ireland	1,948	2,169	2,431	2,664	2,872	11.3	12.1	9.6	7.8
Italy	21,958	24,171	27,698	30,436	32,899	10.1	14.6	9.9	8.1
Netherlands	7,956	8,799	9,622	10,325	10,858	10.6	9.4	7.3	5.2
Norway	2,842	3,016	3,235	3,412	3,573	6.1	7.3	5.5	4.7
Portugal	2,602	2,985	3,308	3,488	3,688	14.7	10.8	5.4	5.7
Spain	10,522	11,322	12,417	13,789	14,652	7.6	9.7	11.1	6.3
Sweden	5,219	5,559	5,949	6,311	6,679	6.5	7.0	6.1	5.8
Switzerland	5,977	6,426	6,895	7,288	7,636	7.5	7.3	5.7	4.8
UK	29,472	31,441	33,139	34,777	36,387	6.7	5.4	4.9	4.6
Western Europe	169,887	183,430	199,086	212,328	224,151	8.0	8.5	6.7	5.6

Table 11
ICT market by country, million ECU

Western Europe	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Austria	6,819	7,504	8,168	8,820	9,446	10.0	8.8	8.0	7.1
Belgium/Luxembourg	9,252	10,205	11,195	12,204	13,124	10.3	9.7	9.0	7.5
Denmark	7,011	7,621	8,160	8,731	9,423	8.7	7.1	7.0	7.9
Finland	4,848	5,300	5,808	6,319	6,824	9.3	9.6	8.8	8.0
France	53,974	58,596	64,374	69,718	75,538	8.6	9.9	8.3	8.3
Germany	77,782	82,867	89,040	95,514	101,972	6.5	7.4	7.3	6.8
Greece	3,600	4,151	4,830	5,400	5,868	15.3	16.3	11.8	8.7
Ireland	3,028	3,358	3,743	4,120	4,470	10.9	11.5	10.1	8.5
Italy	36,152	39,264	44,038	48,138	52,147	8.6	12.2	9.3	8.3
Netherlands	16,210	17,912	19,555	21,207	22,718	10.5	9.2	8.4	7.1
Norway	5,969	6,453	6,977	7,485	8,014	8.1	8.1	7.3	7.1
Portugal	3,734	4,248	4,691	5,001	5,354	13.8	10.4	6.6	7.0
Spain	16,522	17,952	19,678	21,736	23,380	8.7	9.6	10.5	7.6
Sweden	11,736	12,549	13,653	14,854	16,020	6.9	8.8	8.8	7.9
Switzerland	12,795	13,693	14,638	15,700	16,622	7.0	6.9	7.3	5.9
UK	63,008	68,261	73,582	79,199	85,199	8.3	7.8	7.6	7.6
Western Europe	332,440	359,936	392,129	424,147	456,118	8.3	8.9	8.2	7.5

Table 12
Austria
ICT market value, million ECU

Austria	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	460	526	586	635	706	14.5	11.2	8.4	11.2
Unix servers	117	133	149	161	172	14.0	12.2	7.8	6.9
NT servers	19	39	47	56	71	99.2	22.8	19.3	24.8
Other servers	158	168	177	190	202	6.0	5.2	7.5	6.5
Server add-ons	165	187	212	227	261	13.0	13.5	7.1	14.8
Workstations	49	42	39	37	36	-13.6	-8.2	-4.0	-3.5
PCs	647	673	697	711	736	4.0	3.5	2.1	3.6
portable	122	129	140	139	159	5.6	8.6	0.0	14.3
desktop	525	544	557	571	577	3.7	2.3	2.6	1.0
PC/workstation add-ons	211	234	252	259	260	11.1	7.7	2.6	0.6
PC printers	134	150	156	157	151	12.0	3.9	0.5	-3.7
Other add-ons	77	84	96	102	109	9.5	14.5	5.9	7.3
Computer hardware	**1,366**	**1,475**	**1,573**	**1,641**	**1,738**	**8.0**	**6.6**	**4.3**	**5.9**
Copiers	87	88	90	92	94	1.7	2.1	2.2	1.9
Other office equipment	87	87	88	90	90	- 0.4	1.5	1.3	1.0
Office equipment	**174**	**175**	**178**	**181**	**184**	**0.6**	**1.8**	**1.8**	**1.5**
LAN hardware	81	94	115	127	138	16.2	21.9	10.6	8.8
Other data communications	22	23	26	28	30	3.5	13.5	10.0	6.8
Data communications hardware	**103**	**117**	**140**	**155**	**168**	**13.5**	**20.3**	**10.4**	**8.4**
IT hardware	**1,643**	**1,767**	**1,892**	**1,978**	**2,090**	**7.6**	**7.0**	**4.6**	**5.7**
Systems software	311	343	394	458	525	10.3	14.9	16.3	14.6
Application software	287	316	365	429	501	10.1	15.6	17.3	17.0
Software products	**597**	**659**	**759**	**886**	**1,026**	**10.2**	**15.2**	**16.8**	**15.8**
Consulting	99	113	129	151	166	13.4	14.3	16.7	10.2
Implementation	312	389	441	515	558	24.6	13.4	16.7	8.5
Operations management	441	500	534	578	614	13.6	6.7	8.3	6.2
Support services	351	345	352	363	373	- 1.6	2.0	3.2	2.7
Services	**1,203**	**1,347**	**1,456**	**1,607**	**1,711**	**12.0**	**8.1**	**10.3**	**6.5**
Software and services	**1,800**	**2,006**	**2,215**	**2,493**	**2,737**	**11.4**	**10.4**	**12.6**	**9.8**
Total IT market	**3,443**	**3,773**	**4,106**	**4,470**	**4,827**	**9.6**	**8.8**	**8.9**	**8.0**
Switching	256	237	223	224	224	- 7.5	-5.8	0.1	0.1
Transmission	105	109	117	122	128	4.1	7.4	4.3	4.2
Mobile communications infrastructure	78	94	112	125	137	21.4	19.3	10.8	10.1
Public network equipment	**439**	**441**	**453**	**471**	**488**	**0.4**	**2.8**	**3.9**	**3.8**
PABX and key systems	52	53	55	56	59	2.5	2.9	2.3	4.0
Telephone sets	79	79	80	81	83	- 1.0	1.4	1.8	1.7
Mobile terminal equipment	37	54	68	82	98	45.5	27.3	20.3	19.5
Other terminal equipment	73	77	84	95	107	6.0	8.4	13.2	13.5
Private network equipment	**241**	**263**	**287**	**314**	**347**	**9.0**	**9.0**	**9.6**	**10.3**
Telecom equipment	**680**	**704**	**740**	**785**	**835**	**3.4**	**5.1**	**6.1**	**6.4**
Telephone services	1,972	2,053	2,159	2,228	2,274	4.1	5.2	3.2	2.1
Mobile telephone services	255	421	531	614	683	64.7	26.2	15.7	11.3
Switched data and leased line services	311	362	397	445	496	16.3	9.9	11.9	11.5
CaTV services	157	192	234	277	330	22.2	21.8	18.2	19.0
Telecom services	**2,696**	**3,027**	**3,322**	**3,564**	**3,784**	**12.3**	**9.7**	**7.3**	**6.1**
Total telecom	**3,376**	**3,731**	**4,061**	**4,349**	**4,619**	**10.5**	**8.9**	**7.1**	**6.2**
Total ICT	**6,819**	**7,504**	**8,168**	**8,820**	**9,446**	**10.0**	**8.8**	**8.0**	**7.1**

Table 13
Belgium/Luxembourg
ICT market value, million ECU

Belgium/Luxembourg	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	573	653	696	742	797	13.9	6.6	6.6	7.4
Unix servers	147	175	195	218	241	19.5	11.4	11.5	11.0
NT servers	30	52	62	71	87	76.4	18.5	14.7	22.2
Other servers	202	211	219	227	237	4.7	3.5	3.9	4.4
Server add-ons	195	215	221	227	232	9.7	2.8	2.8	2.4
Workstations	73	66	61	59	57	-9.3	-7.7	-3.7	-3.1
PCs	695	772	834	876	896	11.2	8.0	5.1	2.2
portable	148	174	208	222	212	17.5	19.7	6.7	-4.6
desktop	546	598	625	654	683	9.5	4.6	4.6	4.5
PC/workstation add-ons	237	276	306	323	332	16.5	10.8	5.5	2.9
PC printers	152	165	174	178	181	8.7	5.4	2.3	1.4
Other add-ons	85	111	132	145	151	30.6	18.7	9.7	4.8
Computer hardware	**1,578**	**1,768**	**1,897**	**2,000**	**2,082**	**12.0**	**7.3**	**5.4**	**4.1**
Copiers	156	159	162	165	168	1.7	1.9	1.7	1.6
Other office equipment	144	142	143	144	145	-1.3	0.4	0.8	0.6
Office equipment	**300**	**301**	**305**	**309**	**312**	**0.3**	**1.2**	**1.3**	**1.1**
LAN hardware	145	167	194	218	231	15.3	16.1	12.3	5.6
Other data communications	32	34	38	41	44	5.7	13.3	8.9	5.5
Data communications hardware	**177**	**201**	**232**	**260**	**274**	**13.6**	**15.7**	**11.8**	**5.6**
IT hardware	**2,055**	**2,270**	**2,434**	**2,569**	**2,669**	**10.4**	**7.3**	**5.5**	**3.9**
Systems software	607	682	785	904	1,023	12.5	15.0	15.1	13.2
Application software	471	528	607	700	790	12.2	14.9	15.4	12.8
Software products	**1,077**	**1,210**	**1,392**	**1,604**	**1,813**	**12.4**	**15.0**	**15.2**	**13.0**
Consulting	97	120	142	164	179	24.4	18.1	15.5	8.7
Implementation	591	677	779	950	1,095	14.6	15.1	21.9	15.2
Operations management	183	202	215	229	243	10.5	6.3	6.6	6.0
Support services	538	552	579	600	623	2.7	4.8	3.7	3.7
Services	**1,408**	**1,552**	**1,715**	**1,944**	**2,139**	**10.2**	**10.5**	**13.3**	**10.1**
Software and services	**2,485**	**2,762**	**3,107**	**3,548**	**3,952**	**11.1**	**12.5**	**14.2**	**11.4**
Total IT market	**4,540**	**5,032**	**5,541**	**6,117**	**6,621**	**10.8**	**10.1**	**10.4**	**8.2**
Switching	214	197	190	192	192	-8.3	-3.6	1.1	0.1
Transmission	102	104	110	115	119	1.6	5.8	4.4	3.6
Mobile communications infrastructure	77	93	116	134	160	20.8	24.5	15.9	19.0
Public network equipment	**394**	**394**	**415**	**441**	**470**	**0.0**	**5.5**	**6.1**	**6.8**
PABX and key systems	61	62	63	65	68	0.8	2.4	3.6	3.5
Telephone sets	98	103	106	110	115	4.6	3.5	4.2	4.1
Mobile terminal equipment	54	68	79	96	117	25.9	17.0	21.7	20.9
Other terminal equipment	42	52	64	77	92	23.4	23.2	20.4	20.0
Private network equipment	**255**	**284**	**312**	**349**	**391**	**11.3**	**10.1**	**11.8**	**12.1**
Telecom equipment	**649**	**677**	**728**	**790**	**862**	**4.4**	**7.4**	**8.5**	**9.1**
Telephone services	2,553	2,646	2,726	2,822	2,919	3.6	3.0	3.5	3.4
Mobile telephone services	453	661	910	1,064	1,147	45.9	37.8	16.8	7.8
Switched data and leased line services	612	715	784	881	1,018	16.7	9.7	12.3	15.5
CaTV services	445	474	506	531	558	6.5	6.6	5.0	5.0
Telecom services	**4,063**	**4,496**	**4,926**	**5,298**	**5,642**	**10.6**	**9.6**	**7.5**	**6.5**
Total telecom	**4,712**	**5,173**	**5,654**	**6,088**	**6,503**	**9.8**	**9.3**	**7.7**	**6.8**
Total ICT	**9,252**	**10,205**	**11,195**	**12,204**	**13,124**	**10.3**	**9.7**	**9.0**	**7.5**

Table 14
Denmark
ICT market value, million ECU

Denmark	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	366	433	471	511	554	18.4	8.7	8.4	8.4
Unix servers	72	77	87	97	106	7.5	12.1	11.3	9.9
NT servers	22	45	51	60	74	98.2	15.4	17.0	23.4
Other servers	142	156	163	170	174	10.2	4.5	4.0	2.4
Server add-ons	130	155	170	185	199	19.4	9.4	8.9	7.8
Workstations	34	28	26	25	24	-16.8	-8.4	-4.0	-3.4
PCs	996	1,055	1,009	944	947	6.0	-4.4	-6.4	0.4
portable	182	195	188	175	175	7.1	-3.6	-7.0	-0.3
desktop	814	860	820	769	773	5.7	-4.6	-6.3	0.5
PC/workstation add-ons	229	261	288	308	323	14.0	10.1	7.1	4.9
PC printers	134	149	163	173	180	11.1	9.2	6.3	4.0
Other add-ons	95	112	125	135	144	18.2	11.3	8.1	6.1
Computer hardware	**1,625**	**1,778**	**1,794**	**1,788**	**1,848**	**9.4**	**0.9**	**-0.3**	**3.4**
Copiers	107	110	112	113	113	2.9	2.0	0.6	0.2
Other office equipment	90	89	90	86	85	- 1.0	0.7	-3.7	-1.8
Office equipment	**197**	**199**	**202**	**199**	**198**	**1.1**	**1.4**	**-1.3**	**-0.7**
LAN hardware	115	134	151	169	187	16.7	12.3	12.1	10.5
Other data communications	37	38	43	48	53	2.5	12.5	10.8	12.3
Data communications hardware	**152**	**173**	**194**	**217**	**241**	**13.2**	**12.4**	**11.8**	**10.9**
IT hardware	**1,974**	**2,150**	**2,189**	**2,203**	**2,286**	**8.9**	**1.8**	**0.6**	**3.8**
Systems software	265	295	341	398	460	11.2	15.4	16.9	15.6
Application software	264	299	345	398	455	13.1	15.6	15.3	14.3
Software products	**529**	**594**	**686**	**796**	**915**	**12.1**	**15.5**	**16.1**	**15.0**
Consulting	136	148	177	212	244	9.1	19.4	19.4	15.1
Implementation	502	559	663	787	922	11.3	18.8	18.6	17.2
Operations management	365	404	470	531	596	10.6	16.5	13.0	12.1
Support services	350	357	370	388	409	1.8	3.8	4.8	5.3
Services	**1,353**	**1,467**	**1,681**	**1,918**	**2,170**	**8.4**	**14.6**	**14.1**	**13.1**
Software and services	**1,883**	**2,061**	**2,367**	**2,714**	**3,085**	**9.5**	**14.8**	**14.7**	**13.7**
Total IT market	**3,857**	**4,211**	**4,556**	**4,917**	**5,372**	**9.2**	**8.2**	**7.9**	**9.2**
Switching	96	93	95	93	95	- 2.8	2.0	-2.3	1.9
Transmission	93	94	98	98	101	1.4	4.5	-0.9	3.1
Mobile communications infrastructure	67	76	86	89	97	13.7	12.4	4.5	9.0
Public network equipment	**256**	**264**	**279**	**280**	**293**	**3.0**	**5.9**	**0.3**	**4.6**
PABX and key systems	39	39	39	40	41	- 0.3	1.5	1.6	2.1
Telephone sets	65	69	73	74	76	5.8	5.3	2.4	2.4
Mobile terminal equipment	64	66	74	79	86	3.1	11.8	6.9	9.6
Other terminal equipment	39	47	56	62	69	19.7	19.9	10.2	12.2
Private network equipment	**207**	**220**	**242**	**255**	**273**	**6.4**	**9.7**	**5.4**	**6.9**
Telecom equipment	**463**	**484**	**521**	**535**	**566**	**4.6**	**7.6**	**2.7**	**5.7**
Telephone services	1,718	1,785	1,847	1,910	1,970	3.9	3.4	3.5	3.1
Mobile telephone services	498	603	645	703	749	21.1	6.9	9.1	6.5
Switched data and leased line services	296	325	352	388	438	9.8	8.3	10.3	12.9
CaTV services	179	213	240	277	328	19.0	12.5	15.5	18.4
Telecom services	**2,691**	**2,926**	**3,083**	**3,279**	**3,486**	**8.7**	**5.4**	**6.3**	**6.3**
Total telecom	**3,154**	**3,411**	**3,605**	**3,814**	**4,051**	**8.1**	**5.7**	**5.8**	**6.2**
Total ICT	**7,011**	**7,621**	**8,160**	**8,731**	**9,423**	**8.7**	**7.1**	**7.0**	**7.9**

Finland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	233	289	321	358	402	23.8	11.0	11.5	12.3
Unix servers	66	72	87	105	120	9.7	21.2	20.0	14.2
NT servers	20	39	45	49	59	92.1	13.3	11.0	19.0
Other servers	70	79	85	91	102	13.3	6.8	7.8	12.1
Server add-ons	77	98	104	112	121	27.2	5.9	7.6	8.4
Workstations	48	41	38	36	35	-13.2	-8.1	-4.2	-3.5
PCs	575	620	617	634	652	7.9	-0.5	2.7	2.8
portable	108	123	140	139	145	13.6	14.0	-0.7	4.4
desktop	467	497	477	495	506	6.5	-4.1	3.8	2.3
PC/workstation add-ons	149	169	173	178	183	13.4	2.4	3.0	2.5
PC printers	89	100	98	97	96	12.4	-1.7	-1.2	-1.2
Other add-ons	60	69	75	82	87	14.8	8.4	8.5	7.0
Computer hardware	**1,005**	**1,119**	**1,149**	**1,206**	**1,271**	**11.4**	**2.6**	**5.0**	**5.4**
Copiers	62	64	65	67	68	2.6	2.3	2.0	1.8
Other office equipment	57	57	58	59	60	-0.3	1.8	2.2	1.7
Office equipment	**120**	**121**	**123**	**126**	**128**	**1.2**	**2.1**	**2.1**	**1.8**
LAN hardware	117	135	152	170	186	15.7	12.4	12.0	9.3
Other data communications	41	42	48	56	62	4.0	12.6	17.2	11.2
Data communications hardware	**157**	**177**	**200**	**226**	**248**	**12.7**	**12.5**	**13.3**	**9.8**
IT hardware	**1,282**	**1,418**	**1,472**	**1,559**	**1,648**	**10.6**	**3.8**	**5.9**	**5.7**
Systems software	172	194	222	253	287	12.2	14.8	14.0	13.3
Application software	187	205	236	270	309	10.0	14.8	14.6	14.3
Software products	**359**	**399**	**458**	**523**	**596**	**11.1**	**14.8**	**14.3**	**13.8**
Consulting	98	111	137	164	189	12.7	23.5	20.0	15.1
Implementation	283	323	397	477	560	14.4	22.7	20.4	17.3
Operations management	185	211	241	270	297	13.9	14.5	12.0	10.0
Support services	220	227	242	258	276	3.2	6.5	6.5	7.0
Services	**786**	**872**	**1,016**	**1,169**	**1,322**	**10.9**	**16.6**	**15.0**	**13.0**
Software and services	**1,145**	**1,271**	**1,474**	**1,693**	**1,918**	**11.0**	**16.0**	**14.8**	**13.3**
Total IT market	**2,427**	**2,688**	**2,946**	**3,251**	**3,565**	**10.8**	**9.6**	**10.4**	**9.7**
Switching	82	83	86	83	84	1.2	3.6	-3.0	0.4
Transmission	83	82	85	83	85	-0.9	3.5	-2.2	2.5
Mobile communications infrastructure	93	100	109	113	120	7.3	8.5	4.4	5.7
Public network equipment	**258**	**265**	**279**	**280**	**289**	**2.7**	**5.4**	**0.1**	**3.2**
PABX and key systems	46	46	47	47	48	-0.9	1.8	1.6	2.0
Telephone sets	62	64	67	68	71	4.1	4.1	2.4	3.8
Mobile terminal equipment	97	105	116	124	135	8.2	10.5	6.9	8.6
Other terminal equipment	46	51	57	61	66	10.7	11.2	6.8	8.5
Private network equipment	**251**	**266**	**287**	**301**	**320**	**6.0**	**7.6**	**5.0**	**6.4**
Telecom equipment	**510**	**532**	**566**	**581**	**609**	**4.3**	**6.5**	**2.6**	**4.9**
Telephone services	1,031	1,064	1,099	1,130	1,155	3.3	3.3	2.8	2.2
Mobile telephone services	459	541	673	784	857	17.9	24.5	16.4	9.3
Switched data and leased line services	302	336	363	383	397	11.4	8.1	5.3	3.8
CaTV services	120	139	160	191	240	15.4	14.8	19.9	25.6
Telecom services	**1,911**	**2,080**	**2,295**	**2,487**	**2,649**	**8.8**	**10.3**	**8.4**	**6.5**
Total telecom	**2,421**	**2,612**	**2,862**	**3,068**	**3,258**	**7.9**	**9.6**	**7.2**	**6.2**
Total ICT	**4,848**	**5,300**	**5,808**	**6,319**	**6,824**	**9.3**	**9.6**	**8.8**	**8.0**

Table 15
Finland
ICT market value, million ECU

Table 16
France
ICT market value, million ECU

France	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	2,978	3,213	3,338	3,535	3,712	7.9	3.9	5.9	5.0
Unix servers	681	734	793	866	931	7.8	8.0	9.2	7.5
NT servers	111	219	277	351	415	96.7	26.9	26.6	18.2
Other servers	1,077	1,076	1,072	1,093	1,122	0.0	-0.5	2.0	2.6
Server add-ons	1,109	1,184	1,196	1,225	1,245	6.7	1.0	2.4	1.6
Workstations	398	343	312	297	285	-13.8	-9.0	- 5.0	-4.0
PCs	3,848	4,155	4,449	4,675	5,070	8.0	7.1	5.1	8.4
portable	777	834	909	938	1,011	7.3	9.0	3.2	7.8
desktop	3,071	3,321	3,540	3,737	4,059	8.1	6.6	5.6	8.6
PC/workstation add-ons	1,326	1,487	1,557	1,599	1,689	12.1	4.7	2.7	5.6
PC printers	855	891	864	847	849	4.2	-3.0	- 2.0	0.2
Other add-ons	471	597	693	752	840	26.5	16.1	8.6	11.8
Computer hardware	**8,551**	**9,198**	**9,655**	**10,105**	**10,756**	**7.6**	**5.0**	**4.7**	**6.4**
Copiers	919	937	954	934	940	1.9	1.9	- 2.1	0.6
Other office equipment	779	792	809	790	781	1.6	2.2	- 2.3	-1.1
Office equipment	**1,698**	**1,728**	**1,763**	**1,724**	**1,721**	**1.8**	**2.0**	**- 2.2**	**-0.2**
LAN hardware	531	622	729	788	851	17.1	17.1	8.2	8.0
Other data communications	299	312	366	392	443	4.3	17.3	7.2	13.0
Data communications hardware	**830**	**934**	**1,094**	**1,180**	**1,294**	**12.5**	**17.2**	**7.8**	**9.6**
IT hardware	**11,079**	**11,861**	**12,513**	**13,010**	**13,770**	**7.1**	**5.5**	**4.0**	**5.8**
Systems software	2,236	2,352	2,547	2,776	3,017	5.2	8.3	9.0	8.7
Application software	2,393	2,661	3,033	3,453	3,940	11.2	14.0	13.8	14.1
Software products	**4,629**	**5,013**	**5,581**	**6,229**	**6,957**	**8.3**	**11.3**	**11.6**	**11.7**
Consulting	1,184	1,370	1,668	1,994	2,371	15.7	21.8	19.5	18.9
Implementation	3,434	3,963	4,628	5,403	6,214	15.4	16.8	16.8	15.0
Operations management	5,207	5,611	6,277	7,265	8,456	7.8	11.9	15.7	16.4
Support services	3,196	3,301	3,501	3,715	3,901	3.3	6.1	6.1	5.0
Services	**13,020**	**14,245**	**16,074**	**18,377**	**20,942**	**9.4**	**12.8**	**14.3**	**14.0**
Software and services	**17,649**	**19,257**	**21,655**	**24,607**	**27,899**	**9.1**	**12.4**	**13.6**	**13.4**
Total IT market	**28,729**	**31,118**	**34,167**	**37,616**	**41,669**	**8.3**	**9.8**	**10.1**	**10.8**
Switching	781	696	735	658	665	-10.9	5.6	-10.5	1.1
Transmission	490	523	642	601	637	6.7	22.6	- 6.3	6.0
Mobile communications infrastructure	443	560	740	812	891	26.5	32.2	9.7	9.7
Public network equipment	**1,714**	**1,779**	**2,117**	**2,070**	**2,193**	**3.8**	**19.0**	**- 2.2**	**5.9**
PABX and key systems	572	562	567	573	581	- 1.8	1.0	1.0	1.4
Telephone sets	834	841	855	866	880	0.9	1.6	1.4	1.6
Mobile terminal equipment	519	675	758	866	982	29.9	12.3	14.3	13.4
Other terminal equipment	874	1,012	1,178	1,348	1,539	15.7	16.4	14.4	14.2
Private network equipment	**2,800**	**3,089**	**3,357**	**3,653**	**3,981**	**10.3**	**8.7**	**8.8**	**9.0**
Telecom equipment	**4,514**	**4,868**	**5,473**	**5,723**	**6,174**	**7.8**	**12.4**	**4.6**	**7.9**
Telephone services	15,192	15,530	16,118	16,657	17,192	2.2	3.8	3.3	3.2
Mobile telephone services	1,845	2,530	3,827	4,688	5,176	37.1	51.2	22.5	10.4
Switched data and leased line services	3,415	4,232	4,421	4,610	4,829	23.9	4.5	4.3	4.8
CaTV services	277	318	367	424	497	14.6	15.5	15.5	17.2
Telecom services	**20,731**	**22,610**	**24,733**	**26,379**	**27,695**	**9.1**	**9.4**	**6.7**	**5.0**
Total telecom	**25,245**	**27,478**	**30,206**	**32,102**	**33,869**	**8.8**	**9.9**	**6.3**	**5.5**
Total ICT	**53,974**	**58,596**	**64,374**	**69,718**	**75,538**	**8.6**	**9.9**	**8.3**	**8.3**

Germany	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	6,084	6,503	6,942	7,375	7,817	6.9	6.8	6.2	6.0
Unix servers	1,562	1,664	1,775	1,918	2,090	6.5	6.7	8.0	9.0
NT servers	431	737	1,003	1,153	1,292	71.0	36.0	15.0	12.0
Other servers	1,879	1,757	1,678	1,694	1,711	- 6.5	- 4.5	1.0	1.0
Server add-ons	2,212	2,345	2,486	2,610	2,724	6.0	6.0	5.0	4.4
Workstations	885	779	740	740	718	-12.0	- 5.0	0.0	-3.0
PCs	6,190	6,704	7,267	7,945	8,638	8.3	8.4	9.3	8.7
portable	1,675	1,878	2,103	2,419	2,781	12.1	12.0	15.0	15.0
desktop	4,515	4,826	5,164	5,526	5,857	6.9	7.0	7.0	6.0
PC/workstation add-ons	2,506	2,610	2,796	3,000	3,142	4.2	7.1	7.3	4.7
PC printers	1,792	1,846	1,910	1,987	2,026	3.0	3.5	4.0	2.0
Other add-ons	714	764	886	1,013	1,116	7.0	16.0	14.3	10.3
Computer hardware	**15,665**	**16,596**	**17,745**	**19,060**	**20,315**	**5.9**	**6.9**	**7.4**	**6.6**
Copiers	1,334	1,334	1,360	1,394	1,422	0.0	2.0	2.5	2.0
Other office equipment	598	598	604	616	628	0.0	1.0	2.0	2.0
Office equipment	**1,932**	**1,932**	**1,964**	**2,010**	**2,050**	**0.0**	**1.7**	**2.3**	**2.0**
LAN hardware	776	1,016	1,199	1,379	1,517	30.9	18.0	15.0	10.0
Other data communications	174	187	202	217	232	7.5	8.0	7.0	7.0
Data communications hardware	**950**	**1,203**	**1,401**	**1,596**	**1,749**	**26.6**	**16.5**	**13.9**	**9.6**
IT hardware	**18,547**	**19,731**	**21,110**	**22,666**	**24,114**	**6.4**	**7.0**	**7.4**	**6.4**
Systems software	4,206	4,450	4,863	5,316	5,794	5.8	9.3	9.3	9.0
Application software	5,119	5,733	6,536	7,385	8,308	12.0	14.0	13.0	12.5
Software products	**9,325**	**10,183**	**11,399**	**12,701**	**14,102**	**9.2**	**11.9**	**11.4**	**11.0**
Consulting	1,132	1,254	1,417	1,587	1,779	10.8	13.0	12.0	12.1
Implementation	3,659	4,069	4,680	5,522	6,350	11.2	15.0	18.0	15.0
Operations management	2,941	3,253	3,692	4,246	4,883	10.6	13.5	15.0	15.0
Support services	2,501	2,503	2,576	2,658	2,762	0.1	2.9	3.2	3.9
Services	**10,233**	**11,079**	**12,365**	**14,013**	**15,774**	**8.3**	**11.6**	**13.3**	**12.6**
Software and services	**19,558**	**21,262**	**23,764**	**26,714**	**29,876**	**8.7**	**11.8**	**12.4**	**11.8**
Total IT market	**38,105**	**40,993**	**44,874**	**49,380**	**53,990**	**7.6**	**9.5**	**10.0**	**9.3**
Switching	2,477	2,271	1,765	1,597	1,477	- 8.3	-22.3	-9.5	-7.5
Transmission	577	506	590	627	687	-12.3	16.6	6.3	9.5
Mobile communications infrastructure	509	661	839	970	1,141	30.0	26.9	15.6	17.6
Public network equipment	**3,563**	**3,438**	**3,194**	**3,194**	**3,305**	**- 3.5**	**- 7.1**	**0.0**	**3.5**
PABX and key systems	912	933	951	967	994	2.2	2.0	1.7	2.7
Telephone sets	1,512	1,586	1,661	1,718	1,776	4.9	4.7	3.4	3.4
Mobile terminal equipment	447	458	467	484	500	2.5	2.0	3.5	3.4
Other terminal equipment	1,248	1,400	1,538	1,675	1,822	12.2	9.9	8.9	8.8
Private network equipment	**4,120**	**4,377**	**4,617**	**4,844**	**5,091**	**6.3**	**5.5**	**4.9**	**5.1**
Telecom equipment	**7,683**	**7,816**	**7,811**	**8,038**	**8,396**	**1.7**	**- 0.1**	**2.9**	**4.5**
Telephone services	22,451	23,222	24,033	24,795	25,492	3.4	3.5	3.2	2.8
Mobile telephone services	3,397	3,944	4,859	5,477	5,771	16.1	23.2	12.7	5.4
Switched data and leased line services	4,624	5,270	5,692	5,942	6,301	14.0	8.0	4.4	6.1
CaTV services	1,522	1,623	1,769	1,883	2,021	6.6	9.0	6.4	7.3
Telecom services	**31,995**	**34,058**	**36,354**	**38,097**	**39,586**	**6.5**	**6.7**	**4.8**	**3.9**
Total telecom	**39,677**	**41,874**	**44,166**	**46,134**	**47,982**	**5.5**	**5.5**	**4.5**	**4.0**
Total ICT	**77,782**	**82,867**	**89,040**	**95,514**	**101,972**	**6.5**	**7.4**	**7.3**	**6.8**

Table 17
Germany
ICT market value, million ECU

Table 18
Greece
ICT market value, million ECU

Greece	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	58	68	77	83	92	17.7	14.1	7.7	10.3
Unix servers	15	16	17	19	21	3.1	8.1	10.5	10.0
NT servers	4	8	10	11	14	128.3	22.0	12.0	23.2
Other servers	14	18	22	24	27	21.6	25.3	7.8	12.3
Server add-ons	24	26	28	29	30	8.0	7.6	4.5	3.8
Workstations	16	14	13	12	12	-9.3	-8.6	-4.3	-3.0
PCs	160	183	212	245	270	14.2	15.9	15.7	10.2
portable	14	17	20	23	25	19.0	17.8	13.9	9.1
desktop	146	166	192	222	245	13.7	15.7	15.9	10.3
PC/workstation add-ons	87	103	120	146	178	17.3	17.1	21.4	21.7
PC printers	58	66	76	89	100	14.9	15.1	16.5	13.3
Other add-ons	30	37	44	57	77	22.0	20.7	29.8	34.8
Computer hardware	**321**	**367**	**422**	**487**	**552**	**14.5**	**14.9**	**15.3**	**13.3**
Copiers	53	54	56	57	59	3.0	3.3	2.7	2.7
Other office equipment	55	56	57	59	60	1.1	2.7	2.1	2.1
Office equipment	**108**	**110**	**113**	**116**	**119**	**2.0**	**3.0**	**2.4**	**2.4**
LAN hardware	13	15	17	19	21	11.8	12.5	12.5	11.5
Other data communications	2	2	2	3	3	0.8	6.4	9.5	14.4
Data communications hardware	**16**	**17**	**19**	**21**	**24**	**10.1**	**11.7**	**12.1**	**11.9**
IT hardware	**444**	**495**	**555**	**624**	**694**	**11.3**	**12.2**	**12.5**	**11.3**
Systems software	40	47	57	66	76	18.6	20.3	17.0	15.4
Application software	54	65	76	89	102	19.3	16.9	17.5	14.2
Software products	**94**	**112**	**132**	**155**	**178**	**19.0**	**18.3**	**17.3**	**14.7**
Consulting	23	25	28	32	38	11.1	11.7	14.9	16.9
Implementation	71	85	95	109	121	19.7	11.1	14.2	11.5
Operations management	98	104	111	122	132	6.5	6.5	9.6	8.0
Support services	64	67	71	77	82	5.1	5.7	7.7	6.7
Services	**256**	**282**	**305**	**339**	**372**	**10.2**	**8.2**	**11.1**	**9.7**
Software and services	**350**	**394**	**438**	**494**	**550**	**12.6**	**11.0**	**13.0**	**11.3**
Total IT market	**794**	**889**	**992**	**1,119**	**1,245**	**11.9**	**11.7**	**12.7**	**11.3**
Switching	85	86	92	94	97	0.6	7.0	2.4	3.2
Transmission	83	86	91	94	97	3.0	5.8	3.4	3.4
Mobile communications infrastructure	59	70	83	101	123	19.4	18.3	22.6	21.8
Public network equipment	**227**	**241**	**265**	**289**	**317**	**6.3**	**9.8**	**9.1**	**9.8**
PABX and key systems	22	23	25	26	28	4.9	6.6	6.2	7.6
Telephone sets	58	62	65	68	72	5.6	6.0	4.4	5.9
Mobile terminal equipment	23	29	35	40	47	26.4	21.7	14.5	17.3
Other terminal equipment	35	43	52	60	69	23.9	20.9	14.1	15.9
Private network equipment	**138**	**157**	**177**	**194**	**217**	**13.6**	**13.1**	**9.5**	**11.6**
Telecom equipment	**365**	**398**	**443**	**483**	**534**	**9.1**	**11.1**	**9.3**	**10.5**
Telephone services	1,943	2,107	2,395	2,652	2,859	8.4	13.7	10.7	7.8
Mobile telephone services	415	651	874	998	1,060	57.0	34.2	14.3	6.2
Switched data and leased line services	83	107	126	148	170	28.3	18.1	17.2	14.8
CaTV services	0	0	0	0	0	–	–	–	–
Telecom services	**2,440**	**2,864**	**3,395**	**3,798**	**4,089**	**17.4**	**18.5**	**11.9**	**7.7**
Total telecom	**2,806**	**3,263**	**3,837**	**4,282**	**4,623**	**16.3**	**17.6**	**11.6**	**8.0**
Total ICT	**3,600**	**4,151**	**4,830**	**5,400**	**5,868**	**15.3**	**16.3**	**11.8**	**8.7**

Ireland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	119	133	161	185	215	11.6	20.9	15.5	15.7
Unix servers	26	26	33	40	46	-1.1	29.6	19.3	15.9
NT servers	11	21	28	35	44	85.4	33.0	28.6	24.7
Other servers	43	40	45	50	57	-5.8	11.5	11.4	15.4
Server add-ons	39	46	55	60	67	18.1	18.9	9.9	10.7
Workstations	18	16	15	14	13	-9.6	-8.3	-4.5	-3.2
PCs	291	322	353	390	413	10.6	9.6	10.5	6.0
portable	48	55	62	66	70	16.2	12.1	6.7	5.6
desktop	243	266	291	323	343	9.5	9.1	11.3	6.1
PC/workstation add-ons	69	84	93	102	109	21.3	11.0	8.8	7.5
PC printers	36	41	45	48	52	11.4	11.3	6.8	8.6
Other add-ons	33	44	48	53	57	32.3	10.7	10.7	6.5
Computer hardware	**497**	**554**	**621**	**691**	**750**	**11.6**	**12.0**	**11.2**	**8.7**
Copiers	85	83	83	83	84	-2.9	-0.1	0.7	1.0
Other office equipment	83	82	83	84	85	-1.0	1.8	0.7	1.4
Office equipment	**168**	**165**	**166**	**167**	**169**	**-2.0**	**0.8**	**0.7**	**1.2**
LAN hardware	16	18	21	23	24	12.5	15.1	10.6	6.3
Other data communications	6	6	7	8	9	-1.4	13.2	14.9	9.0
Data communications hardware	**22**	**24**	**27**	**31**	**33**	**8.6**	**14.6**	**11.7**	**7.0**
IT hardware	**686**	**743**	**814**	**888**	**952**	**8.2**	**9.6**	**9.1**	**7.2**
Systems software	77	86	98	114	132	11.8	14.0	16.3	15.8
Application software	60	68	79	95	114	12.3	16.9	20.0	19.5
Software products	**138**	**154**	**178**	**210**	**246**	**12.0**	**15.3**	**18.0**	**17.5**
Consulting	23	26	30	35	41	13.3	16.3	19.0	16.5
Implementation	72	90	100	118	135	25.1	11.1	18.2	14.4
Operations management	100	111	122	132	146	11.1	10.0	8.2	10.8
Support services	62	66	68	73	77	5.1	4.3	6.4	6.1
Services	**257**	**292**	**320**	**358**	**399**	**13.8**	**9.6**	**11.9**	**11.6**
Software and services	**394**	**446**	**497**	**568**	**646**	**13.2**	**11.6**	**14.1**	**13.8**
Total IT market	**1,081**	**1,189**	**1,312**	**1,456**	**1,598**	**10.0**	**10.3**	**11.0**	**9.8**
Switching	69	70	73	76	79	2.1	3.6	4.1	3.8
Transmission	33	34	36	39	42	4.7	5.4	7.6	7.2
Mobile communications infrastructure	32	37	41	47	53	15.9	10.1	14.5	13.9
Public network equipment	**134**	**142**	**150**	**162**	**174**	**6.0**	**5.7**	**7.8**	**7.5**
PABX and key systems	26	28	31	35	41	6.9	10.6	13.3	15.6
Telephone sets	51	56	62	67	73	9.8	9.4	8.7	8.5
Mobile terminal equipment	21	25	28	32	35	20.4	13.2	12.9	12.0
Other terminal equipment	31	37	43	49	57	18.9	15.0	15.3	15.9
Private network equipment	**130**	**146**	**164**	**183**	**206**	**13.1**	**11.7**	**12.0**	**12.4**
Telecom equipment	**263**	**288**	**314**	**345**	**380**	**9.5**	**8.8**	**10.0**	**10.1**
Telephone services	1,314	1,396	1,505	1,607	1,698	6.2	7.8	6.8	5.7
Mobile telephone services	210	292	391	455	491	39.3	34.0	16.3	7.9
Switched data and leased line services	110	129	149	166	182	17.9	15.1	11.8	9.1
CaTV services	51	63	73	91	122	23.4	15.4	24.3	34.1
Telecom services	**1,685**	**1,881**	**2,118**	**2,319**	**2,492**	**11.6**	**12.6**	**9.5**	**7.5**
Total telecom	**1,948**	**2,169**	**2,431**	**2,664**	**2,872**	**11.3**	**12.1**	**9.6**	**7.8**
Total ICT	**3,028**	**3,358**	**3,743**	**4,120**	**4,470**	**10.9**	**11.5**	**10.1**	**8.5**

Table 19
Ireland
ICT market value, million ECU

Table 20
Italy
ICT market value, million ECU

Italy	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	2,083	2,096	2,186	2,247	2,362	0.6	4.3	2.8	5.1
Unix servers	306	306	337	354	395	0.3	9.9	5.2	11.5
NT servers	61	122	140	154	175	98.2	14.9	10.4	13.1
Other servers	883	892	895	891	900	1.0	0.3	-0.4	1.0
Server add-ons	833	775	814	847	893	-6.9	5.0	4.0	5.4
Workstations	240	235	214	207	201	-2.1	-9.0	-3.0	-3.0
PCs	1,761	1,932	2,085	2,226	2,400	9.7	7.9	6.8	7.8
portable	338	386	413	434	475	14.0	7.1	5.0	9.5
desktop	1,422	1,546	1,671	1,793	1,925	8.7	8.1	7.3	7.4
PC/workstation add-ons	799	858	893	918	936	7.4	4.0	2.8	2.0
PC printers	577	607	599	587	575	5.4	-1.4	-2.0	-2.0
Other add-ons	222	251	294	331	361	12.9	17.2	12.5	9.1
Computer hardware	**4,883**	**5,121**	**5,377**	**5,599**	**5,900**	**4.9**	**5.0**	**4.1**	**5.4**
Copiers	464	476	485	494	504	2.6	2.1	1.8	1.9
Other office equipment	246	235	235	236	240	-4.4	-0.3	0.6	1.7
Office equipment	**710**	**711**	**720**	**730**	**744**	**0.2**	**1.3**	**1.4**	**1.9**
LAN hardware	258	310	346	378	404	20.5	11.5	9.1	6.9
Other data communications	93	98	120	139	148	4.4	22.4	15.9	7.1
Data communications hardware	**351**	**408**	**466**	**516**	**552**	**16.2**	**14.1**	**10.8**	**7.0**
IT hardware	**5,943**	**6,240**	**6,563**	**6,845**	**7,196**	**5.0**	**5.2**	**4.3**	**5.1**
Systems software	1,535	1,608	1,728	1,867	2,014	4.7	7.5	8.1	7.9
Application software	1,113	1,181	1,293	1,413	1,548	6.1	9.4	9.3	9.5
Software products	**2,648**	**2,789**	**3,021**	**3,280**	**3,562**	**5.3**	**8.3**	**8.6**	**8.6**
Consulting	456	497	556	624	706	9.1	11.8	12.2	13.2
Implementation	1,406	1,564	1,772	2,007	2,294	11.2	13.3	13.3	14.3
Operations management	2,146	2,397	2,764	3,213	3,683	11.7	15.3	16.2	14.6
Support services	1,593	1,606	1,664	1,733	1,807	0.8	3.6	4.2	4.2
Services	**5,602**	**6,064**	**6,756**	**7,577**	**8,490**	**8.3**	**11.4**	**12.2**	**12.0**
Software and services	**8,250**	**8,854**	**9,777**	**10,857**	**12,052**	**7.3**	**10.4**	**11.1**	**11.0**
Total IT market	**14,193**	**15,093**	**16,340**	**17,702**	**19,248**	**6.3**	**8.3**	**8.3**	**8.7**
Switching	810	806	890	939	959	-0.5	10.3	5.6	2.1
Transmission	502	518	618	681	727	3.2	19.5	10.1	6.8
Mobile communications infrastructure	490	558	896	1,216	1,453	13.8	60.7	35.6	19.5
Public network equipment	**1,802**	**1,882**	**2,404**	**2,836**	**3,139**	**4.4**	**27.8**	**17.9**	**10.7**
PABX and key systems	220	218	235	250	267	-0.9	7.5	6.4	6.7
Telephone sets	483	504	534	560	584	4.5	5.9	4.8	4.4
Mobile terminal equipment	767	847	882	898	921	10.4	4.1	1.8	2.6
Other terminal equipment	450	486	541	600	663	8.0	11.3	10.8	10.6
Private network equipment	**1,921**	**2,056**	**2,192**	**2,307**	**2,436**	**7.0**	**6.6**	**5.2**	**5.6**
Telecom equipment	**3,723**	**3,938**	**4,597**	**5,143**	**5,575**	**5.8**	**16.7**	**11.9**	**8.4**
Telephone services	13,223	13,488	13,820	14,299	14,783	2.0	2.5	3.5	3.4
Mobile telephone services	3,553	4,832	6,910	8,430	9,695	36.0	43.0	22.0	15.0
Switched data and leased line services	1,447	1,889	2,338	2,517	2,785	30.6	23.7	7.7	10.6
CaTV services	13	23	34	46	61	74.9	48.6	33.7	32.8
Telecom services	**18,236**	**20,233**	**23,102**	**25,293**	**27,324**	**11.0**	**14.2**	**9.5**	**8.0**
Total telecom	**21,958**	**24,171**	**27,698**	**30,436**	**32,899**	**10.1**	**14.6**	**9.9**	**8.1**
Total ICT	**36,152**	**39,264**	**44,038**	**48,138**	**52,147**	**8.6**	**12.2**	**9.3**	**8.3**

Netherlands	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	896	1,022	1,119	1,193	1,293	14.1	9.5	6.6	8.4
Unix servers	185	198	216	235	254	7.3	9.0	8.8	8.0
NT servers	61	118	151	174	212	93.9	28.2	15.0	22.2
Other servers	318	334	344	351	366	5.0	2.8	2.1	4.3
Server add-ons	332	372	408	433	460	11.9	9.7	6.1	6.3
Workstations	114	100	91	88	85	-12.4	-8.3	-4.1	-3.5
PCs	1,625	1,792	1,878	1,988	2,137	10.3	4.8	5.8	7.5
portable	330	366	414	449	483	10.7	13.2	8.5	7.5
desktop	1,294	1,426	1,464	1,539	1,654	10.2	2.7	5.1	7.5
PC/workstation add-ons	419	436	434	445	457	4.2	-0.6	2.6	2.7
PC printers	261	277	266	270	273	5.8	-3.9	1.5	1.0
Other add-ons	157	159	168	175	184	1.4	5.3	4.2	5.3
Computer hardware	**3,053**	**3,350**	**3,522**	**3,713**	**3,971**	**9.7**	**5.1**	**5.4**	**6.9**
Copiers	374	378	378	390	401	1.1	0.2	3.2	2.8
Other office equipment	322	324	323	334	345	0.7	-0.2	3.5	3.3
Office equipment	**695**	**702**	**702**	**725**	**747**	**0.9**	**0.0**	**3.3**	**3.0**
LAN hardware	298	342	372	403	426	14.6	9.0	8.4	5.7
Other data communications	113	115	125	135	143	1.4	9.2	8.1	5.7
Data communications hardware	**411**	**456**	**498**	**539**	**570**	**11.0**	**9.0**	**8.3**	**5.7**
IT hardware	**4,160**	**4,508**	**4,721**	**4,977**	**5,287**	**8.4**	**4.7**	**5.4**	**6.2**
Systems software	975	1,109	1,246	1,427	1,619	13.7	12.4	14.6	13.4
Application software	900	984	1,105	1,265	1,429	9.3	12.3	14.5	12.9
Software products	**1,875**	**2,092**	**2,351**	**2,692**	**3,048**	**11.6**	**12.3**	**14.5**	**13.2**
Consulting	233	275	331	370	403	17.9	20.3	12.0	8.9
Implementation	868	1,026	1,222	1,446	1,636	18.2	19.1	18.3	13.2
Operations management	473	552	612	661	707	16.7	10.8	8.0	7.0
Support services	645	660	696	736	778	2.3	5.5	5.7	5.7
Services	**2,220**	**2,513**	**2,861**	**3,213**	**3,525**	**13.2**	**13.8**	**12.3**	**9.7**
Software and services	**4,095**	**4,606**	**5,212**	**5,906**	**6,573**	**12.5**	**13.2**	**13.3**	**11.3**
Total IT market	**8,254**	**9,113**	**9,933**	**10,882**	**11,860**	**10.4**	**9.0**	**9.6**	**9.0**
Switching	225	218	219	221	222	- 2.9	0.1	1.0	0.6
Transmission	155	158	167	166	169	1.7	5.8	-0.5	1.8
Mobile communications infrastructure	133	140	153	163	176	5.1	9.5	6.8	7.8
Public network equipment	**513**	**516**	**538**	**550**	**568**	**0.6**	**4.4**	**2.2**	**3.1**
PABX and key systems	201	203	205	206	208	0.9	1.2	0.5	1.0
Telephone sets	186	196	207	215	224	5.3	5.5	3.8	4.2
Mobile terminal equipment	219	239	260	285	313	9.2	8.7	9.8	9.6
Other terminal equipment	193	227	264	292	327	17.7	16.6	10.3	12.1
Private network equipment	**798**	**864**	**936**	**998**	**1,071**	**8.3**	**8.3**	**6.6**	**7.4**
Telecom equipment	**1,311**	**1,380**	**1,474**	**1,548**	**1,639**	**5.3**	**6.8**	**5.0**	**5.9**
Telephone services	4,287	4,417	4,734	4,951	5,081	3.0	7.2	4.6	2.6
Mobile telephone services	1,006	1,421	1,723	2,024	2,171	41.3	21.3	17.4	7.3
Switched data and leased line services	739	930	1,002	1,076	1,196	25.8	7.7	7.5	11.1
CaTV services	613	651	689	726	771	6.2	5.9	5.4	6.2
Telecom services	**6,645**	**7,419**	**8,148**	**8,777**	**9,219**	**11.6**	**9.8**	**7.7**	**5.0**
Total telecom	**7,956**	**8,799**	**9,622**	**10,325**	**10,858**	**10.6**	**9.4**	**7.3**	**5.2**
Total ICT	**16,210**	**17,912**	**19,555**	**21,207**	**22,718**	**10.5**	**9.2**	**8.4**	**7.1**

Table 21
Netherlands
ICT market value, million ECU

Table 22
Norway
ICT market value, million ECU

Norway	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	278	342	379	420	471	22.9	10.9	10.7	12.1
Unix servers	62	70	80	91	103	11.7	15.0	14.1	12.2
NT servers	25	50	56	64	75	95.4	13.1	13.5	18.4
Other servers	95	101	108	117	132	6.3	7.9	8.1	12.3
Server add-ons	96	122	135	148	161	27.4	10.1	9.7	9.3
Workstations	53	47	43	42	40	−10.2	−8.4	−4.0	− 3.6
PCs	717	766	743	714	704	6.9	−3.0	−4.0	− 1.3
portable	135	146	155	150	133	7.9	5.7	−2.9	−11.6
desktop	582	620	589	564	572	6.7	−5.1	−4.3	1.4
PC/workstation add-ons	182	210	212	203	203	15.6	1.0	−4.4	0.0
PC printers	104	120	118	115	113	14.7	−1.4	−2.3	− 1.9
Other add-ons	77	90	94	87	90	16.7	4.2	−7.1	2.6
Computer hardware	**1,230**	**1,366**	**1,378**	**1,378**	**1,418**	**11.1**	**0.9**	**0.0**	**2.9**
Copiers	64	65	66	66	67	1.1	0.8	0.8	0.8
Other office equipment	71	72	73	74	75	1.4	0.6	1.5	1.4
Office equipment	**136**	**138**	**139**	**140**	**142**	**1.3**	**0.7**	**1.1**	**1.1**
LAN hardware	104	116	128	139	148	11.6	10.4	8.9	5.8
Other data communications	39	41	45	49	53	5.1	10.5	8.7	8.2
Data communications hardware	**143**	**157**	**174**	**189**	**201**	**9.8**	**10.4**	**8.9**	**6.4**
IT hardware	**1,509**	**1,661**	**1,690**	**1,707**	**1,761**	**10.1**	**1.8**	**1.0**	**3.2**
Systems software	234	268	307	350	395	14.8	14.4	14.0	12.9
Application software	237	265	299	340	385	11.9	12.9	13.5	13.2
Software products	**471**	**533**	**606**	**690**	**780**	**13.4**	**13.7**	**13.7**	**13.1**
Consulting	129	143	170	202	236	11.3	18.6	18.5	17.0
Implementation	436	481	581	703	818	10.4	20.7	20.9	16.4
Operations management	291	323	386	445	504	11.0	19.5	15.3	13.3
Support services	292	296	309	327	342	1.5	4.4	5.8	4.6
Services	**1,147**	**1,244**	**1,446**	**1,676**	**1,900**	**8.4**	**16.3**	**15.9**	**13.3**
Software and services	**1,618**	**1,777**	**2,052**	**2,365**	**2,679**	**9.8**	**15.5**	**15.3**	**13.3**
Total IT market	**3,126**	**3,437**	**3,742**	**4,073**	**4,440**	**9.9**	**8.9**	**8.8**	**9.0**
Switching	104	98	98	96	98	− 5.7	−0.6	−1.4	1.6
Transmission	102	106	117	118	125	3.6	10.4	0.6	5.7
Mobile communications infrastructure	50	54	61	66	73	8.0	13.7	8.2	9.6
Public network equipment	**257**	**258**	**276**	**281**	**295**	**0.7**	**6.9**	**1.6**	**5.2**
PABX and key systems	31	31	31	31	32	− 0.3	0.2	1.0	1.0
Telephone sets	73	77	80	84	87	5.4	3.9	4.3	4.2
Mobile terminal equipment	94	89	88	89	91	− 5.3	−0.8	1.5	1.5
Other terminal equipment	56	67	80	92	105	19.5	20.0	14.5	14.5
Private network equipment	**254**	**264**	**280**	**296**	**315**	**3.9**	**6.0**	**6.0**	**6.2**
Telecom equipment	**511**	**522**	**556**	**577**	**610**	**2.3**	**6.4**	**3.8**	**5.7**
Telephone services	1,495	1,528	1,595	1,651	1,702	2.2	4.4	3.5	3.1
Mobile telephone services	498	578	675	747	791	16.0	16.8	10.7	5.9
Switched data and leased line services	283	325	340	361	383	14.6	4.8	6.1	6.3
CaTV services	55	63	68	76	87	14.4	9.2	11.4	13.8
Telecom services	**2,331**	**2,493**	**2,679**	**2,835**	**2,963**	**6.9**	**7.4**	**5.8**	**4.5**
Total telecom	**2,842**	**3,016**	**3,235**	**3,412**	**3,573**	**6.1**	**7.3**	**5.5**	**4.7**
Total ICT	**5,969**	**6,453**	**6,977**	**7,485**	**8,014**	**8.1**	**8.1**	**7.3**	**7.1**

Portugal	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	179	216	243	277	320	20.5	12.3	14.2	15.5
Unix servers	58	66	76	83	90	14.6	14.8	9.3	8.7
NT servers	11	20	25	33	44	74.5	29.9	30.3	34.2
Other servers	50	54	58	67	79	8.1	7.6	16.5	17.9
Server add-ons	61	77	84	94	107	26.2	8.9	12.1	13.2
Workstations	16	14	13	13	12	-10.1	-8.3	- 4.2	-3.3
PCs	288	311	341	367	406	8.1	9.5	7.8	10.4
portable	15	16	19	22	23	9.5	18.5	13.1	7.9
desktop	273	295	322	346	382	8.1	9.0	7.5	10.6
PC/workstation add-ons	64	74	84	92	101	15.6	13.3	9.1	10.2
PC printers	18	19	21	21	22	8.7	6.6	3.4	3.6
Other add-ons	46	55	64	71	79	18.3	15.7	11.0	12.2
Computer hardware	**548**	**616**	**681**	**749**	**839**	**12.5**	**10.5**	**10.0**	**12.0**
Copiers	64	65	67	68	70	2.0	1.7	2.2	2.2
Other office equipment	65	66	68	69	70	2.3	1.9	1.8	2.4
Office equipment	**129**	**132**	**134**	**137**	**140**	**2.2**	**1.8**	**2.0**	**2.3**
LAN hardware	13	15	17	19	21	14.7	12.5	12.5	7.1
Other data communications	8	8	9	11	12	6.3	10.7	16.9	9.8
Data communications hardware	**21**	**23**	**26**	**30**	**32**	**11.6**	**11.9**	**14.0**	**8.1**
IT hardware	**697**	**771**	**841**	**916**	**1,011**	**10.6**	**9.1**	**8.9**	**10.5**
Systems software	78	89	100	113	128	14.0	12.5	13.6	13.5
Application software	57	67	75	85	97	17.8	11.9	13.8	14.0
Software products	**134**	**155**	**174**	**198**	**225**	**15.6**	**12.2**	**13.7**	**13.7**
Consulting	27	30	34	38	42	13.8	12.2	10.5	10.7
Implementation	81	95	104	114	122	17.2	9.5	9.3	7.5
Operations management	115	129	141	153	163	12.7	9.1	8.1	6.6
Support Services	77	82	89	96	103	6.0	8.2	8.3	7.4
Services	**300**	**337**	**368**	**400**	**430**	**12.3**	**9.3**	**8.7**	**7.4**
Software and services	**434**	**492**	**542**	**598**	**655**	**13.3**	**10.2**	**10.3**	**9.5**
Total IT market	**1,131**	**1,263**	**1,383**	**1,514**	**1,666**	**11.6**	**9.5**	**9.4**	**10.1**
Switching	71	69	65	30	30	- 2.7	-7.1	-53.7	1.4
Transmission	50	54	57	54	61	7.4	6.0	- 5.1	13.5
Mobile communications infrastructure	44	79	113	123	121	79.5	44.4	8.1	-1.0
Public network equipment	**165**	**202**	**235**	**206**	**213**	**22.1**	**16.4**	**-12.1**	**3.2**
PABX and key systems	47	48	50	52	54	1.7	2.9	4.8	4.7
Telephone sets	75	79	83	87	91	5.8	4.9	4.7	4.6
Mobile terminal equipment	13	16	18	21	23	23.4	9.7	15.2	14.3
Other terminal equipment	52	63	73	82	91	21.1	15.6	11.6	11.3
Private network equipment	**188**	**207**	**224**	**241**	**260**	**10.3**	**8.1**	**7.9**	**7.7**
Telecom equipment	**353**	**409**	**458**	**448**	**473**	**15.8**	**12.2**	**- 2.4**	**5.6**
Telephone services	1,783	1,896	2,007	2,107	2,213	6.3	5.8	5.0	5.1
Mobile telephone services	265	458	606	681	729	73.0	32.3	12.4	6.9
Switched data and leased line services	201	220	228	235	242	9.3	3.5	3.3	3.0
CaTV services	0	5	9	17	31	-	87.7	86.1	84.4
Telecom services	**2,249**	**2,577**	**2,849**	**3,040**	**3,215**	**14.6**	**10.6**	**6.7**	**5.7**
Total telecom	**2,602**	**2,985**	**3,308**	**3,488**	**3,688**	**14.7**	**10.8**	**5.4**	**5.7**
Total ICT	**3,734**	**4,248**	**4,691**	**5,001**	**5,354**	**13.8**	**10.4**	**6.6**	**7.0**

Table 23
Portugal
ICT market value, million ECU

Table 24
Spain
ICT market value, million ECU

Spain	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	871	997	1,071	1,168	1,273	14.5	7.4	9.0	9.0
Unix servers	163	169	185	201	218	4.0	9.0	9.0	8.3
NT servers	38	79	95	118	151	108.5	20.2	24.2	27.6
Other servers	358	392	408	430	459	9.4	4.1	5.4	6.8
Server add-ons	312	357	383	418	445	14.3	7.5	9.0	6.4
Workstations	106	92	84	81	78	-13.6	-8.2	-4.1	-3.6
PCs	1,094	1,207	1,312	1,398	1,523	10.3	8.7	6.5	9.0
portable	193	214	254	255	296	10.4	18.8	0.6	15.9
desktop	901	993	1,058	1,142	1,228	10.3	6.5	8.0	7.5
PC/Workstation add-ons	427	476	497	501	506	11.5	4.4	0.8	1.1
PC printers	298	332	336	329	319	11.2	1.3	-2.0	-3.1
Other add-ons	129	144	161	172	187	12.1	11.5	6.6	9.1
Computer hardware	**2,498**	**2,772**	**2,965**	**3,147**	**3,380**	**11.0**	**6.9**	**6.1**	**7.4**
Copiers	293	290	288	281	278	- 0.8	-0.9	-2.2	-1.2
Other office equipment	269	270	267	257	253	0.1	-1.1	-3.5	-1.9
Office equipment	**562**	**560**	**554**	**539**	**531**	**- 0.4**	**-1.0**	**-2.8**	**-1.5**
LAN hardware	165	204	231	254	274	23.7	13.4	10.0	7.7
Other data communications	59	63	72	82	90	6.9	14.3	12.9	10.4
Data communications hardware	**224**	**267**	**304**	**336**	**364**	**19.3**	**13.6**	**10.7**	**8.4**
IT hardware	**3,284**	**3,599**	**3,822**	**4,022**	**4,275**	**9.6**	**6.2**	**5.2**	**6.3**
Systems software	466	510	572	658	751	9.5	12.3	15.0	14.1
Application software	403	447	513	592	682	10.8	15.0	15.2	15.2
Software products	**869**	**956**	**1,086**	**1,250**	**1,433**	**10.1**	**13.5**	**15.1**	**14.7**
Consulting	164	185	219	274	337	12.7	18.6	25.1	23.2
Implementation	541	660	778	889	1,006	21.9	18.0	14.2	13.2
Operations management	727	797	885	1,002	1,139	9.7	11.0	13.3	13.7
Support services	416	433	471	510	537	4.0	8.8	8.2	5.5
Services	**1,848**	**2,074**	**2,353**	**2,675**	**3,020**	**12.3**	**13.4**	**13.7**	**12.9**
Software and services	**2,716**	**3,031**	**3,439**	**3,924**	**4,453**	**11.6**	**13.5**	**14.1**	**13.5**
Total IT market	**6,000**	**6,630**	**7,261**	**7,946**	**8,728**	**10.5**	**9.5**	**9.4**	**9.8**
Switching	399	485	529	620	674	21.4	9.2	17.2	8.6
Transmission	269	275	285	314	334	2.3	3.6	10.3	6.4
Mobile communications infrastructure	272	290	342	559	552	6.8	17.8	63.6	-1.3
Public network equipment	**940**	**1,050**	**1,156**	**1,494**	**1,559**	**11.7**	**10.1**	**29.2**	**4.4**
PABX and key systems	223	180	193	207	222	-19.5	7.3	7.0	7.4
Telephone sets	218	215	238	256	277	- 1.4	10.5	7.8	8.0
Mobile terminal equipment	108	140	174	204	239	29.2	24.2	17.3	17.3
Other terminal equipment	135	155	189	225	267	15.0	21.5	19.1	18.8
Private network equipment	**685**	**690**	**793**	**891**	**1,005**	**0.8**	**14.9**	**12.4**	**12.7**
Telecom equipment	**1,625**	**1,740**	**1,949**	**2,385**	**2,564**	**7.1**	**12.0**	**22.4**	**7.5**
Telephone services	6,696	6,855	7,177	7,515	7,851	2.4	4.7	4.7	4.5
Mobile telephone services	1,269	1,650	2,115	2,629	2,898	30.0	28.2	24.3	10.2
Switched data and leased line services	827	962	1,048	1,121	1,185	16.3	8.9	7.0	5.8
CaTV services	105	116	127	139	154	10.4	10.0	9.3	11.1
Telecom services	**8,897**	**9,583**	**10,468**	**11,404**	**12,089**	**7.7**	**9.2**	**8.9**	**6.0**
Total telecom	**10,522**	**11,322**	**12,417**	**13,789**	**14,652**	**7.6**	**9.7**	**11.1**	**6.3**
Total ICT	**16,522**	**17,952**	**19,678**	**21,736**	**23,380**	**8.7**	**9.6**	**10.5**	**7.6**

Sweden	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	614	677	733	807	889	10.2	8.3	10.1	10.1
Unix servers	137	145	169	196	219	6.3	16.3	15.8	12.0
NT servers	44	89	103	122	148	99.1	16.8	17.7	21.7
Other servers	183	189	189	192	200	3.4	-0.1	2.0	4.0
Server add-ons	250	254	272	298	322	1.5	7.0	9.3	8.1
Workstations	148	132	121	116	112	-10.2	-8.3	-4.1	-3.5
PCs	1,386	1,425	1,456	1,503	1,485	2.8	2.2	3.2	-1.2
portable	364	374	370	378	375	2.8	-1.2	2.3	-1.0
desktop	1,022	1,050	1,086	1,125	1,111	2.8	3.4	3.6	-1.3
PC/workstation add-ons	357	387	399	410	409	8.2	3.3	2.6	-0.1
PC printers	204	221	221	219	215	8.1	0.0	-0.6	-2.0
Other add-ons	153	166	179	190	194	8.4	7.6	6.6	2.1
Computer hardware	**2,505**	**2,621**	**2,710**	**2,837**	**2,896**	**4.6**	**3.4**	**4.7**	**2.1**
Copiers	130	129	128	127	127	- 0.4	-1.0	-1.1	0.1
Other office equipment	126	123	117	114	111	- 2.4	-4.7	-2.7	-2.4
Office equipment	**255**	**252**	**245**	**240**	**238**	**- 1.4**	**-2.8**	**-1.9**	**-1.1**
LAN hardware	245	283	322	355	375	15.5	14.0	10.3	5.5
Other data communications	65	68	72	79	84	4.4	7.2	8.4	7.4
Data communications hardware	**309**	**350**	**395**	**434**	**459**	**13.2**	**12.7**	**9.9**	**5.9**
IT hardware	**3,070**	**3,223**	**3,350**	**3,511**	**3,593**	**5.0**	**3.9**	**4.8**	**2.3**
Systems software	392	426	477	538	603	8.7	11.9	12.8	12.1
Application software	389	430	485	552	625	10.3	13.0	13.7	13.3
Software products	**782**	**856**	**962**	**1,090**	**1,228**	**9.5**	**12.4**	**13.3**	**12.7**
Consulting	241	268	326	391	460	11.3	21.7	20.0	17.6
Implementation	1,112	1,230	1,517	1,862	2,231	10.6	23.3	22.7	19.8
Operations management	633	718	801	885	969	13.4	11.5	10.5	9.5
Support services	680	694	748	804	860	2.2	7.7	7.5	7.0
Services	**2,666**	**2,911**	**3,391**	**3,942**	**4,520**	**9.2**	**16.5**	**16.2**	**14.7**
Software and services	**3,447**	**3,767**	**4,354**	**5,032**	**5,748**	**9.3**	**15.6**	**15.6**	**14.2**
Total IT market	**6,517**	**6,990**	**7,703**	**8,543**	**9,341**	**7.3**	**10.2**	**10.9**	**9.3**
Switching	173	173	180	173	178	0.3	4.0	-4.0	3.2
Transmission	102	105	112	111	115	3.4	6.0	-0.8	3.7
Mobile communications infrastructure	142	156	169	177	186	9.8	8.7	4.2	5.2
Public network equipment	**416**	**434**	**461**	**460**	**479**	**4.3**	**6.2**	**-0.2**	**4.1**
PABX and key systems	122	115	110	106	102	- 5.3	-4.7	-3.5	-3.4
Telephone sets	186	179	183	183	185	- 3.4	2.0	0.0	1.0
Mobile terminal equipment	239	236	234	238	242	- 1.3	-0.7	1.6	1.6
Other terminal equipment	168	185	207	227	249	10.2	12.1	9.8	9.6
Private network equipment	**714**	**715**	**734**	**754**	**778**	**0.2**	**2.6**	**2.7**	**3.2**
Telecom equipment	**1,130**	**1,149**	**1,195**	**1,214**	**1,257**	**1.7**	**4.0**	**1.6**	**3.5**
Telephone services	2,428	2,482	2,575	2,658	2,732	2.2	3.8	3.2	2.8
Mobile telephone services	980	1,111	1,235	1,371	1,476	13.4	11.2	10.9	7.7
Switched data and leased line services	384	456	493	531	565	18.7	8.0	7.7	6.5
CaTV services	296	361	451	538	649	21.7	25.0	19.1	20.8
Telecom services	**4,089**	**4,410**	**4,754**	**5,097**	**5,422**	**7.9**	**7.8**	**7.2**	**6.4**
Total telecom	**5,219**	**5,559**	**5,949**	**6,311**	**6,679**	**6.5**	**7.0**	**6.1**	**5.8**
Total ICT	**11,736**	**12,549**	**13,653**	**14,854**	**16,020**	**6.9**	**8.8**	**8.8**	**7.9**

Table 25
Sweden
ICT market value, million ECU

Table 26
Switzerland
ICT market value, million ECU

Switzerland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	876	977	1,112	1,228	1,307	11.6	13.9	10.4	6.4
Unix servers	271	320	388	438	473	18.3	21.3	12.8	7.9
NT servers	42	82	116	153	187	95.8	41.9	31.6	22.2
Other servers	282	297	307	316	320	5.5	3.1	3.1	1.1
Server add-ons	281	278	301	320	327	- 1.3	8.5	6.3	2.2
Workstations	145	127	117	113	111	-12.5	-7.8	-3.6	-2.1
PCs	1,130	1,177	1,202	1,267	1,286	4.2	2.1	5.4	1.5
portable	299	312	339	352	359	4.4	8.6	3.6	2.0
desktop	831	865	862	915	927	4.1	-0.3	6.1	1.3
PC/workstation add-ons	356	365	371	392	393	2.8	1.6	5.4	0.4
PC printers	223	225	208	211	207	0.9	-7.5	1.6	-2.2
Other add-ons	133	140	163	180	186	5.9	16.2	10.3	3.5
Computer hardware	**2,507**	**2,647**	**2,803**	**2,999**	**3,097**	**5.6**	**5.9**	**7.0**	**3.2**
Copiers	106	106	107	108	109	- 0.1	1.0	1.0	1.0
Other office equipment	199	196	198	215	217	- 1.5	1.0	8.5	1.0
Office equipment	**305**	**302**	**305**	**323**	**326**	**- 1.0**	**1.0**	**5.9**	**1.0**
LAN hardware	147	176	200	231	239	19.7	13.8	15.6	3.7
Other data communications	30	29	30	32	35	- 1.7	3.0	7.2	8.3
Data communications hardware	**176**	**205**	**230**	**263**	**274**	**16.1**	**12.2**	**14.5**	**4.3**
IT hardware	**2,988**	**3,154**	**3,338**	**3,585**	**3,697**	**5.5**	**5.8**	**7.4**	**3.1**
Systems software	639	694	750	840	942	8.7	8.0	12.0	12.2
Application software	642	703	782	888	1,004	9.4	11.3	13.6	13.1
Software products	**1,281**	**1,397**	**1,531**	**1,728**	**1,946**	**9.1**	**9.6**	**12.8**	**12.7**
Consulting	273	284	307	351	385	4.0	7.8	14.6	9.7
Implementation	719	787	857	918	991	9.4	8.9	7.2	7.9
Operations management	962	1,032	1,082	1,169	1,273	7.3	4.8	8.1	8.9
Support services	594	613	629	660	692	3.2	2.6	4.9	4.9
Services	**2,549**	**2,716**	**2,874**	**3,099**	**3,342**	**6.6**	**5.8**	**7.8**	**7.8**
Software and services	**3,829**	**4,113**	**4,405**	**4,827**	**5,288**	**7.4**	**7.1**	**9.6**	**9.6**
Total IT market	**6,818**	**7,267**	**7,743**	**8,412**	**8,985**	**6.6**	**6.5**	**8.6**	**6.8**
Switching	257	235	231	216	209	- 8.7	-1.6	-6.2	-3.4
Transmission	278	285	303	309	320	2.4	6.4	2.0	3.6
Mobile communications infrastructure	78	80	82	89	95	2.8	2.3	8.2	6.7
Public network equipment	**613**	**600**	**616**	**614**	**624**	**- 2.2**	**2.7**	**-0.3**	**1.6**
PABX and key systems	95	93	93	94	95	- 2.0	0.0	1.0	1.0
Telephone sets	219	225	233	240	247	3.0	3.1	3.1	3.0
Mobile terminal equipment	80	86	97	106	115	7.3	11.7	9.3	8.9
Other terminal equipment	136	158	183	211	242	16.1	16.2	15.0	14.7
Private network equipment	**530**	**563**	**606**	**650**	**699**	**6.1**	**7.6**	**7.4**	**7.5**
Telecom equipment	**1,144**	**1,163**	**1,222**	**1,265**	**1,323**	**1.7**	**5.1**	**3.5**	**4.6**
Telephone services	3,014	3,119	3,240	3,345	3,437	3.5	3.9	3.3	2.8
Mobile telephone services	524	689	887	1,008	1,059	31.3	28.8	13.7	5.0
Switched data and leased line services	857	962	1,008	1,073	1,152	12.2	4.8	6.4	7.4
CaTV services	438	493	538	597	666	12.6	9.2	11.0	11.4
Telecom services	**4,833**	**5,263**	**5,673**	**6,024**	**6,314**	**8.9**	**7.8**	**6.2**	**4.8**
Total telecom	**5,977**	**6,426**	**6,895**	**7,288**	**7,636**	**7.5**	**7.3**	**5.7**	**4.8**
Total ICT	**12,795**	**13,693**	**14,638**	**15,700**	**16,622**	**7.0**	**6.9**	**7.3**	**5.9**

United Kingdom	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	4,479	4,985	5,547	5,987	6,522	11.3	11.3	7.9	8.9
Unix servers	1,066	1,153	1,340	1,508	1,677	8.2	16.2	12.5	11.2
NT servers	220	425	516	600	731	93.4	21.4	16.3	21.9
Other servers	1,548	1,612	1,699	1,754	1,829	4.2	5.4	3.2	4.2
Server add-ons	1,646	1,795	1,991	2,124	2,285	9.1	10.9	6.7	7.6
Workstations	565	497	457	434	417	-12.0	-8.0	-5.0	-4.0
PCs	6,490	7,006	7,164	7,440	7,954	7.9	2.3	3.9	6.9
portable	1,715	1,862	1,948	1,973	1,977	8.5	4.6	1.3	0.2
desktop	4,775	5,145	5,216	5,468	5,977	7.7	1.4	4.8	9.3
PC/workstation add-ons	1,770	1,897	1,963	2,037	2,125	7.2	3.5	3.8	4.3
PC printers	1,126	1,168	1,149	1,144	1,124	3.7	-1.6	-0.5	-1.7
Other add-ons	643	729	813	893	1,001	13.3	11.5	9.8	12.1
Computer hardware	**13,304**	**14,385**	**15,131**	**15,898**	**17,018**	**8.1**	**5.2**	**5.1**	**7.0**
Copiers	990	982	1,002	1,027	1,045	- 0.7	2.0	2.5	1.7
Other office equipment	892	913	929	943	966	2.3	1.8	1.5	2.4
Office equipment	**1,882**	**1,895**	**1,931**	**1,970**	**2,010**	**0.7**	**1.9**	**2.0**	**2.0**
LAN hardware	1,329	1,552	1,862	2,032	2,118	16.8	20.0	9.1	4.2
Other data communications	476	488	524	583	618	2.5	7.4	11.4	6.0
Data communications hardware	**1,804**	**2,040**	**2,386**	**2,616**	**2,736**	**13.0**	**17.0**	**9.6**	**4.6**
IT hardware	**16,990**	**18,320**	**19,448**	**20,484**	**21,764**	**7.8**	**6.2**	**5.3**	**6.2**
Systems software	3,222	3,625	4,072	4,656	5,308	12.5	12.3	14.3	14.0
Application software	2,991	3,400	3,874	4,465	5,100	13.7	13.9	15.2	14.2
Software products	**6,212**	**7,025**	**7,946**	**9,121**	**10,408**	**13.1**	**13.1**	**14.8**	**14.1**
Consulting	959	1,091	1,319	1,551	1,775	13.8	20.9	17.6	14.4
Implementation	2,700	3,314	3,992	4,795	5,606	22.8	20.4	20.1	16.9
Operations management	3,951	4,286	4,790	5,321	5,847	8.5	11.8	11.1	9.9
Support services	2,724	2,783	2,947	3,150	3,411	2.2	5.9	6.9	8.3
Services	**10,334**	**11,475**	**13,048**	**14,818**	**16,640**	**11.0**	**13.7**	**13.6**	**12.3**
Software and services	**16,546**	**18,500**	**20,994**	**23,938**	**27,048**	**11.8**	**13.5**	**14.0**	**13.0**
Total IT market	**33,536**	**36,820**	**40,442**	**44,422**	**48,812**	**9.8**	**9.8**	**9.8**	**9.9**
Switching	916	928	931	961	1,003	1.3	0.4	3.2	4.4
Transmission	585	598	604	631	671	2.2	1.0	4.5	6.3
Mobile communications infrastructure	564	591	617	661	722	4.7	4.4	7.2	9.2
Public network equipment	**2,065**	**2,117**	**2,152**	**2,253**	**2,396**	**2.5**	**1.7**	**4.7**	**6.3**
PABX and key systems	501	484	469	455	442	- 3.3	-3.2	-3.0	-2.9
Telephone sets	664	705	715	726	736	6.1	1.5	1.4	1.4
Mobile terminal equipment	777	711	668	629	596	- 8.5	-6.1	-5.9	-5.3
Other terminal equipment	1,044	1,265	1,405	1,567	1,744	21.2	11.0	11.5	11.3
Private network equipment	**2,986**	**3,166**	**3,257**	**3,376**	**3,517**	**6.0**	**2.9**	**3.7**	**4.2**
Telecom equipment	**5,051**	**5,282**	**5,409**	**5,629**	**5,913**	**4.6**	**2.4**	**4.1**	**5.0**
Telephone services	14,733	15,091	15,438	15,773	16,100	2.4	2.3	2.2	2.1
Mobile telephone services	4,276	4,836	5,456	5,928	6,234	13.1	12.8	8.6	5.2
Switched data and leased line services	4,626	5,219	5,561	5,898	6,212	12.8	6.6	6.1	5.3
CaTV services	786	1,014	1,276	1,549	1,928	29.0	25.9	21.4	24.5
Telecom services	**24,421**	**26,159**	**27,730**	**29,147**	**30,474**	**7.1**	**6.0**	**5.1**	**4.6**
Total telecom	**29,472**	**31,441**	**33,139**	**34,777**	**36,387**	**6.7**	**5.4**	**4.9**	**4.6**
Total ICT	**63,008**	**68,261**	**73,582**	**79,199**	**85,199**	**8.3**	**7.8**	**7.6**	**7.6**

Table 27
United Kingdom
ICT market value, million ECU

Table 28
Czech Republic
ICT market value, million ECU

Czech Republic	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	120	122	117	130	146	1.6	- 4.2	11.6	11.9
Unix servers	47	42	37	43	43	-11.4	-11.3	15.7	0.8
NT servers	13	26	27	32	38	97.2	3.6	16.2	21.1
Other servers	45	37	32	32	39	-18.1	-13.6	1.6	21.1
Server add-ons	15	17	21	24	25	16.2	20.9	13.3	6.9
Workstations	14	15	15	16	17	2.3	3.8	7.3	4.1
PCs	308	270	256	271	293	-12.2	- 5.2	5.8	8.1
portable	65	50	45	43	42	-22.4	-10.9	-5.3	-1.9
desktop	243	220	211	228	251	- 9.4	- 3.9	8.2	10.0
PC/workstation add-ons	103	94	97	105	117	- 9.6	3.4	8.4	11.3
PC printers	75	64	64	69	77	-15.3	1.3	7.4	11.2
Other add-ons	28	30	32	36	40	5.6	7.9	10.2	11.5
Computer hardware	**545**	**500**	**485**	**523**	**573**	**- 8.3**	**- 3.1**	**7.8**	**9.6**
Copiers	47	46	43	47	50	- 1.7	- 5.7	9.3	6.8
Other office equipment	22	20	18	18	18	- 9.0	- 8.7	0.0	-2.6
Office equipment	**68**	**66**	**61**	**65**	**68**	**- 4.0**	**- 6.6**	**6.6**	**4.2**
LAN hardware	65	70	79	89	96	7.7	13.1	12.8	8.5
Other data communications	14	15	17	18	20	5.6	10.5	9.5	13.0
Data communications hardware	**79**	**85**	**95**	**107**	**117**	**7.3**	**12.6**	**12.2**	**9.3**
IT hardware	**693**	**651**	**642**	**695**	**758**	**- 6.1**	**- 1.4**	**8.3**	**9.0**
Systems software	62	67	74	81	88	7.4	10.6	9.3	8.8
Application software	67	84	94	104	119	24.8	12.3	10.9	14.4
Software products	**129**	**150**	**168**	**185**	**207**	**16.4**	**11.5**	**10.2**	**11.9**
Consulting	70	72	91	98	110	3.6	25.0	7.8	12.1
Implementation	155	159	191	225	263	2.6	19.8	17.8	17.2
Operations management	68	72	79	92	103	6.7	10.2	16.1	12.0
Support services	91	94	101	112	125	3.3	7.6	10.9	12.0
Services	**383**	**398**	**462**	**526**	**601**	**3.7**	**16.1**	**14.0**	**14.2**
Software and services	**513**	**548**	**629**	**711**	**808**	**6.9**	**14.9**	**13.0**	**13.6**
Total IT market	**1,205**	**1,199**	**1,271**	**1,406**	**1,566**	**- 0.6**	**6.0**	**10.6**	**11.4**
Switching	171	204	238	273	315	19.0	17.0	14.6	15.3
Transmission	138	163	192	220	258	17.6	17.7	14.7	17.4
Mobile communications infrastructure	270	326	386	439	516	20.5	18.5	13.7	17.7
Public network equipment	**580**	**692**	**816**	**931**	**1,089**	**19.4**	**17.9**	**14.2**	**16.9**
PABX and key systems	35	41	48	57	65	14.9	17.9	19.2	14.1
Telephone sets	13	15	18	21	24	13.6	17.1	18.1	13.0
Mobile terminal equipment	26	31	36	43	49	19.0	17.9	19.3	14.2
Other terminal equipment	13	15	18	21	24	13.6	18.6	18.1	13.1
Private network equipment	**88**	**102**	**120**	**143**	**162**	**15.7**	**17.9**	**18.9**	**13.8**
Telecom equipment	**668**	**794**	**935**	**1,074**	**1,251**	**18.9**	**17.9**	**14.8**	**16.5**
Telephone services	625	763	870	985	1,099	22.0	14.1	13.2	11.6
Mobile telephone services	151	184	211	242	273	22.0	14.3	14.7	13.1
Switched data and lease line services	38	43	52	58	64	13.6	19.3	13.5	9.4
CaTV services	10	12	13	14	17	14.9	9.3	13.5	22.1
Telecom services	**825**	**1,002**	**1,145**	**1,300**	**1,454**	**21.5**	**14.3**	**13.5**	**11.9**
Total telecom	**1,492**	**1,795**	**2,080**	**2,373**	**2,705**	**20.3**	**15.9**	**14.1**	**14.0**
Total ICT	**2,697**	**2,994**	**3,351**	**3,779**	**4,271**	**11.0**	**11.9**	**12.8**	**13.0**

Hungary	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	84	116	109	127	139	37.8	- 5.7	16.4	8.8
Unix servers	23	47	38	40	40	106.3	-18.7	4.9	0.1
NT servers	10	17	20	28	37	69.7	18.2	39.4	29.4
Other servers	36	38	36	42	42	4.8	- 5.8	16.4	0.8
Server add-ons	15	14	15	17	20	- 8.2	9.0	15.0	14.7
Workstations	6	8	10	11	12	32.7	22.3	9.5	8.7
PCs	147	161	166	177	191	9.8	3.3	6.5	8.0
portable	18	26	28	28	33	45.7	7.8	2.0	16.8
desktop	129	135	139	149	158	4.9	2.4	7.4	6.3
PC/workstation add-ons	73	69	71	73	77	- 4.7	2.0	3.7	5.3
PC printers	49	43	43	43	45	-11.7	- 0.4	0.6	3.5
Other add-ons	24	26	28	30	32	10.0	6.1	8.6	7.9
Computer hardware	**310**	**355**	**356**	**389**	**419**	**14.4**	**0.5**	**9.1**	**7.8**
Copiers	36	38	41	43	45	3.7	7.7	5.4	5.5
Other office equipment	13	13	14	14	14	- 1.8	7.3	0.6	0.6
Office equipment	**50**	**51**	**55**	**57**	**59**	**2.2**	**7.6**	**4.2**	**4.3**
LAN hardware	29	35	41	47	51	20.3	16.5	13.5	9.1
Other data communications	13	14	15	16	17	5.9	8.3	2.6	10.0
Data communications hardware	**43**	**50**	**57**	**63**	**68**	**15.8**	**14.2**	**10.5**	**9.3**
IT hardware	**402**	**455**	**468**	**508**	**547**	**13.1**	**2.8**	**8.7**	**7.6**
Systems software	44	47	50	55	59	5.9	6.7	9.6	7.8
Application software	69	80	92	102	116	15.3	15.3	11.1	13.1
Software products	**113**	**127**	**142**	**157**	**175**	**11.7**	**12.1**	**10.6**	**11.2**
Consulting	50	54	59	63	69	9.0	8.5	8.3	8.8
Implementation	87	103	117	135	151	18.0	13.7	14.8	12.3
Operations management	31	33	41	46	50	6.2	22.9	12.5	8.5
Support services	54	57	63	67	73	4.8	10.5	7.0	7.8
Services	**223**	**248**	**280**	**312**	**343**	**11.1**	**13.1**	**11.3**	**10.0**
Software and services	**336**	**374**	**422**	**469**	**518**	**11.3**	**12.8**	**11.1**	**10.4**
Total IT market	**738**	**829**	**889**	**977**	**1,064**	**12.3**	**7.3**	**9.8**	**9.0**
Switching	123	135	143	151	158	9.9	6.0	5.5	4.5
Transmission	101	108	115	122	128	7.5	6.6	5.6	5.3
Mobile communications infrastructure	195	216	232	243	255	11.1	7.3	4.7	4.9
Public network equipment	**418**	**459**	**490**	**515**	**541**	**9.9**	**6.7**	**5.1**	**4.9**
PABX and key systems	24	27	28	30	31	14.9	4.6	5.6	3.8
Telephone sets	9	10	11	11	11	13.6	3.9	4.6	2.8
Mobile terminal equipment	18	20	21	22	23	11.1	4.6	5.7	3.8
Other terminal equipment	9	10	11	11	11	13.6	5.3	4.7	2.8
Private network equipment	**60**	**68**	**71**	**74**	**77**	**13.4**	**4.6**	**5.4**	**3.5**
Telecom equipment	**478**	**527**	**561**	**590**	**618**	**10.3**	**6.5**	**5.2**	**4.7**
Telephone services	744	826	917	1,027	1,125	11.1	11.0	11.9	9.6
Mobile telephone services	172	200	227	252	276	16.3	13.4	11.3	9.5
Switched data and lease line services	33	37	42	48	51	13.6	12.0	15.1	6.4
CaTV services	11	12	13	15	16	8.7	5.6	11.9	9.5
Telecom services	**960**	**1,076**	**1,199**	**1,342**	**1,469**	**12.1**	**11.4**	**11.9**	**9.5**
Total telecom	**1,437**	**1,603**	**1,760**	**1,932**	**2,087**	**11.5**	**9.8**	**9.8**	**8.0**
Total ICT	**2,176**	**2,432**	**2,649**	**2,909**	**3,151**	**11.8**	**8.9**	**9.8**	**8.3**

Table 29
Hungary
ICT market value, million ECU

Table 30
Poland
ICT market value, million ECU

Poland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	134	168	182	198	219	25.8	8.0	9.0	10.6
Unix servers	49	63	59	61	63	28.1	–5.7	3.1	2.9
NT servers	9	24	31	45	59	156.1	29.8	43.2	30.4
Other servers	57	59	63	60	62	3.0	7.2	–4.4	3.1
Server add-ons	18	23	28	32	36	23.7	25.0	13.3	11.3
Workstations	13	15	17	17	19	18.4	10.5	4.8	7.3
PCs	408	490	577	654	717	20.1	17.6	13.5	9.6
portable	45	55	68	80	89	23.2	23.8	16.6	11.9
desktop	363	435	508	575	628	19.7	16.8	13.1	9.3
PC/workstation add-ons	140	163	171	179	183	16.0	5.2	4.6	2.4
PC printers	105	126	132	136	137	19.9	4.5	3.2	1.1
Other add-ons	35	37	40	43	46	4.4	7.4	8.9	6.4
Computer hardware	**695**	**836**	**946**	**1,049**	**1,139**	**20.3**	**13.2**	**10.9**	**8.5**
Copiers	57	52	61	68	77	–7.6	15.5	13.0	12.1
Other office equipment	32	33	35	36	38	1.0	7.3	4.3	3.5
Office equipment	**89**	**85**	**95**	**105**	**114**	**–4.5**	**12.3**	**9.8**	**9.1**
LAN hardware	66	81	97	109	116	23.1	19.9	12.3	6.3
Other data communications	23	24	26	28	31	6.9	6.5	9.1	8.9
Data communications hardware	**89**	**105**	**123**	**137**	**147**	**18.9**	**16.8**	**11.6**	**6.8**
IT hardware	**873**	**1,027**	**1,165**	**1,291**	**1,400**	**17.7**	**13.5**	**10.9**	**8.4**
Systems software	56	69	78	89	102	22.5	13.8	14.1	14.2
Application software	86	112	133	151	174	30.3	19.0	13.6	15.1
Software products	**142**	**180**	**211**	**240**	**276**	**27.2**	**17.0**	**13.8**	**14.8**
Consulting	35	41	57	75	90	17.4	38.5	31.9	20.0
Implementation	132	170	199	229	277	29.2	16.7	15.5	21.0
Operations management	31	38	41	46	55	22.2	7.7	12.9	18.6
Support services	71	88	97	106	117	24.4	9.8	9.8	9.6
Services	**268**	**337**	**393**	**457**	**538**	**25.6**	**16.6**	**16.2**	**17.9**
Software and services	**410**	**518**	**604**	**697**	**814**	**26.2**	**16.7**	**15.3**	**16.8**
Total IT market	**1,283**	**1,544**	**1,769**	**1,988**	**2,214**	**20.4**	**14.5**	**12.4**	**11.3**
Switching	209	233	261	296	329	11.1	12.2	13.3	11.2
Transmission	164	186	210	238	269	13.6	12.9	13.4	13.2
Mobile communications infrastructure	331	372	423	475	539	12.4	13.6	12.4	13.4
Public network equipment	**704**	**791**	**893**	**1,009**	**1,137**	**12.3**	**13.0**	**12.9**	**12.7**
PABX and key systems	44	47	49	55	61	6.4	6.1	11.4	10.1
Telephone sets	16	17	18	20	22	8.7	5.4	10.4	9.1
Mobile terminal equipment	32	35	37	41	45	8.7	6.1	11.5	10.2
Other terminal equipment	16	17	19	21	22	9.9	6.8	10.4	9.1
Private network equipment	**108**	**116**	**123**	**137**	**151**	**7.9**	**6.1**	**11.1**	**9.9**
Telecom equipment	**812**	**907**	**1,017**	**1,146**	**1,287**	**11.7**	**12.1**	**12.7**	**12.4**
Telephone services	1,431	1,745	2,200	2,682	3,169	22.0	26.1	21.9	18.1
Mobile telephone services	346	422	544	659	778	22.0	28.9	21.3	18.0
Switched data and lease line services	70	79	101	126	145	13.6	27.3	25.4	14.7
CaTV services	23	26	32	39	46	14.9	20.0	21.9	18.0
Telecom services	**1,869**	**2,272**	**2,876**	**3,506**	**4,137**	**21.6**	**26.6**	**21.9**	**18.0**
Total telecom	**2,681**	**3,179**	**3,893**	**4,652**	**5,424**	**18.6**	**22.5**	**19.5**	**16.6**
Total ICT	**3,964**	**4,723**	**5,662**	**6,640**	**7,638**	**19.1**	**19.9**	**17.3**	**15.0**

Russia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	204	276	288	334	403	35.2	4.3	16.2	20.8
Unix servers	65	75	93	103	113	14.7	23.9	11.1	9.0
NT servers	33	75	89	122	162	126.4	18.8	37.4	32.3
Other servers	67	81	80	84	96	20.9	- 1.5	5.6	14.1
Server add-ons	38	45	26	24	33	16.7	-42.1	- 6.1	35.5
Workstations	17	20	19	14	16	12.9	- 4.0	-25.0	11.1
PCs	1,091	1,367	776	510	687	25.3	-43.2	-34.2	34.6
portable	98	127	69	47	58	29.4	-45.5	-32.9	24.6
desktop	993	1,240	707	464	629	24.9	-43.0	-34.3	35.6
PC/workstation add-ons	257	363	257	221	251	41.5	-29.3	-13.8	13.5
PC printers	182	279	204	181	197	53.4	-26.8	-11.2	8.7
Other add-ons	75	84	53	40	54	12.6	-37.4	-24.1	35.0
Computer hardware	**1,569**	**2,026**	**1,339**	**1,080**	**1,357**	**29.1**	**-33.9**	**-19.4**	**25.7**
Copiers	131	173	209	245	262	31.9	21.0	17.4	7.1
Other office equipment	78	79	83	88	87	1.0	5.0	6.7	-1.8
Office equipment	**209**	**251**	**291**	**333**	**349**	**20.4**	**16.0**	**14.3**	**4.7**
LAN hardware	87	142	80	53	71	63.7	-43.5	-34.2	34.6
Other data communications	58	60	43	32	36	2.7	-27.6	-25.0	11.1
Data communications hardware	**145**	**202**	**124**	**85**	**107**	**39.2**	**-38.8**	**-31.0**	**25.6**
IT hardware	**1,923**	**2,479**	**1,754**	**1,499**	**1,813**	**28.9**	**-29.2**	**-14.6**	**21.0**
Systems software	59	69	46	32	40	17.3	-34.1	-31.0	25.8
Application software	94	109	95	88	91	16.0	-13.0	- 6.7	2.7
Software products	**153**	**178**	**140**	**120**	**130**	**16.5**	**-21.2**	**-14.6**	**8.8**
Consulting	24	29	24	20	22	23.3	-18.9	-16.7	12.0
Implementation	126	154	158	126	134	22.5	2.0	-20.0	6.3
Operations management	32	37	29	27	31	14.6	-21.3	- 8.1	14.7
Support services	99	116	95	91	95	16.7	-18.4	- 4.2	4.3
Services	**281**	**336**	**305**	**263**	**281**	**19.6**	**- 9.4**	**-13.7**	**6.9**
Software and services	**434**	**514**	**445**	**383**	**411**	**18.5**	**-13.5**	**-14.0**	**7.5**
Total IT market	**2,357**	**2,993**	**2,200**	**1,881**	**2,225**	**27.0**	**-26.5**	**-14.5**	**18.3**
Switching	703	790	704	571	687	12.4	-10.9	-18.8	20.2
Transmission	624	709	566	460	561	13.6	-20.1	-18.7	22.0
Mobile communications infrastructure	1,177	1,308	1,140	918	1,120	11.1	-12.9	-19.4	22.0
Public network equipment	**2,504**	**2,807**	**2,409**	**1,950**	**2,369**	**12.1**	**-14.2**	**-19.1**	**21.5**
PABX and key systems	167	183	156	118	140	9.9	-14.8	-24.5	18.9
Telephone sets	63	69	58	43	51	8.7	-15.4	-25.2	17.8
Mobile terminal equipment	126	137	117	88	105	8.7	-14.8	-24.4	19.0
Other terminal equipment	63	69	59	44	52	8.7	-14.3	-25.2	17.8
Private network equipment	**419**	**458**	**390**	**294**	**348**	**9.2**	**-14.8**	**-24.7**	**18.6**
Telecom equipment	**2,923**	**3,265**	**2,799**	**2,244**	**2,717**	**11.7**	**-14.3**	**-19.8**	**21.1**
Telephone services	2,898	3,117	2,584	2,335	2,801	7.5	-17.1	- 9.6	20.0
Mobile telephone services	704	782	626	573	697	11.1	-20.0	- 8.4	21.6
Switched data and lease line services	164	187	153	139	163	13.6	-18.0	- 9.4	17.6
CaTV services	44	48	37	34	44	8.7	-21.9	- 9.4	31.2
Telecom services	**3,811**	**4,133**	**3,400**	**3,080**	**3,705**	**8.5**	**-17.7**	**- 9.4**	**20.3**
Total telecom	**6,734**	**7,398**	**6,199**	**5,324**	**6,423**	**9.9**	**-16.2**	**-14.1**	**20.6**
Total ICT	**9,091**	**10,391**	**8,399**	**7,205**	**8,647**	**14.3**	**-19.2**	**-14.2**	**20.0**

Table 31
Russia
ICT market value, million ECU

Table 32
Slovakia
ICT market value, million ECU

Slovakia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	50	50	42	48	50	0.9	-16.8	15.3	3.9
Unix servers	18	18	14	16	16	- 3.2	-20.0	15.5	-1.8
NT servers	5	5	6	9	11	7.0	23.7	41.0	19.2
Other servers	22	21	15	16	15	- 6.0	-26.9	5.1	-3.9
Server add-ons	5	7	6	7	8	41.3	- 8.2	13.6	15.0
Workstations	5	5	5	6	7	0.0	11.5	16.2	8.9
PCs	90	77	79	85	92	-13.9	2.6	7.1	8.2
portable	18	17	17	18	18	- 8.2	1.7	4.5	4.5
desktop	72	61	62	67	73	-15.3	2.9	7.8	9.1
PC/workstation add-ons	30	26	30	31	32	-11.5	12.2	5.6	4.2
PC printers	24	19	20	20	20	-20.9	4.0	1.6	2.2
Other add-ons	6	7	10	11	12	26.7	32.6	13.5	7.7
Computer hardware	**174**	**159**	**156**	**171**	**181**	**- 8.9**	**- 1.7**	**9.3**	**6.3**
Copiers	13	15	13	15	17	11.8	-10.5	11.8	10.5
Other office equipment	6	6	6	6	6	0.0	0.0	0.0	0.0
Office equipment	**20**	**21**	**20**	**21**	**23**	**8.0**	**- 7.4**	**8.0**	**7.4**
LAN hardware	17	17	18	22	25	1.1	6.9	19.2	16.6
Other data communications	2	2	3	3	4	14.8	16.1	16.7	21.4
Data communications hardware	**19**	**19**	**21**	**25**	**29**	**2.7**	**8.1**	**18.9**	**17.2**
IT hardware	**213**	**199**	**197**	**217**	**233**	**- 6.3**	**- 1.3**	**10.2**	**7.6**
Systems software	18	21	25	28	31	20.4	16.6	12.7	11.8
Application software	18	22	27	30	35	21.7	21.4	11.8	15.8
Software products	**36**	**43**	**52**	**58**	**66**	**21.1**	**19.1**	**12.2**	**13.9**
Consulting	5	6	8	10	13	33.3	25.0	30.0	24.6
Implementation	24	27	33	39	48	13.3	23.5	19.0	22.0
Operations management	7	8	9	9	10	11.1	8.0	8.3	7.7
Support services	11	11	13	15	18	7.4	15.2	13.8	21.1
Services	**46**	**52**	**63**	**74**	**89**	**13.7**	**19.5**	**17.9**	**20.4**
Software and services	**82**	**96**	**114**	**132**	**155**	**16.9**	**19.3**	**15.3**	**17.5**
Total IT market	**295**	**295**	**311**	**349**	**388**	**0.2**	**5.4**	**12.1**	**11.4**
Switching	72	81	88	95	101	12.4	8.5	7.8	5.9
Transmission	57	65	71	77	82	13.6	9.2	7.9	6.5
Mobile communications infrastructure	117	130	143	153	165	11.1	9.9	6.9	7.9
Public network equipment	**247**	**277**	**303**	**325**	**348**	**12.1**	**9.3**	**7.4**	**7.0**
PABX and key systems	15	16	18	20	22	9.9	12.0	10.2	9.9
Telephone sets	6	6	7	7	8	8.7	11.3	9.2	8.9
Mobile terminal equipment	11	12	14	15	17	8.7	12.0	10.3	10.0
Other terminal equipment	6	6	7	8	8	8.7	12.8	9.2	8.9
Private network equipment	**37**	**41**	**46**	**50**	**55**	**9.2**	**12.0**	**10.0**	**9.7**
Telecom equipment	**284**	**317**	**348**	**375**	**403**	**11.7**	**9.7**	**7.7**	**7.3**
Telephone services	281	305	331	369	406	8.7	8.4	11.6	10.0
Mobile telephone services	66	74	80	90	101	11.1	8.5	13.1	11.5
Switched data and lease line services	15	17	20	22	24	13.6	13.3	11.9	7.8
CaTV services	4	5	5	5	6	8.7	3.8	11.9	20.3
Telecom services	**366**	**401**	**435**	**486**	**536**	**9.3**	**8.5**	**11.9**	**10.3**
Total telecom	**651**	**718**	**783**	**862**	**939**	**10.4**	**9.0**	**10.0**	**9.0**
Total ICT	**945**	**1,013**	**1,094**	**1,210**	**1,327**	**7.2**	**8.0**	**10.6**	**9.7**

Slovenia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	28	24	25	27	30	-13.1	0.5	8.9	10.8
Unix servers	5	5	5	4	5	- 6.3	11.7	-15.7	25.4
NT servers	3	3	4	6	8	3.1	39.8	38.4	29.6
Other servers	15	12	10	11	10	-20.5	-14.9	6.7	-4.9
Server add-ons	5	5	5	5	6	- 7.0	2.6	12.5	9.4
Workstations	3	3	4	4	4	14.2	10.2	4.5	4.7
PCs	67	69	75	81	89	2.3	9.9	7.4	9.4
portable	10	8	9	10	11	-19.1	13.3	10.4	12.4
desktop	57	60	66	71	77	6.0	9.5	7.0	9.0
PC/workstation add-ons	23	21	22	22	23	- 7.5	5.9	0.6	3.5
PC printers	17	15	16	15	15	-11.7	5.0	- 3.6	-1.5
Other add-ons	6	6	6	7	8	5.7	8.1	11.3	14.6
Computer hardware	**121**	**117**	**126**	**134**	**146**	**- 2.8**	**7.3**	**6.4**	**8.6**
Copiers	9	9	10	11	11	- 8.4	14.7	7.2	7.5
Other office equipment	4	4	4	4	4	- 6.2	6.7	1.8	10.3
Office equipment	**13**	**12**	**14**	**15**	**16**	**- 7.8**	**12.3**	**5.7**	**8.2**
LAN hardware	10	12	15	16	17	23.1	19.9	12.3	6.3
Other data communications	2	2	3	3	3	25.0	13.3	11.8	10.5
Data communications hardware	**12**	**15**	**17**	**19**	**21**	**23.4**	**18.8**	**12.2**	**6.9**
IT hardware	**146**	**144**	**157**	**168**	**182**	**- 1.2**	**8.8**	**7.0**	**8.3**
Systems software	17	18	20	21	22	8.6	11.8	5.9	5.6
Application software	17	20	22	25	28	13.6	12.0	14.3	10.6
Software products	**34**	**38**	**42**	**46**	**50**	**11.2**	**11.9**	**10.3**	**8.3**
Consulting	3	3	4	5	6	10.0	13.6	16.0	22.4
Implementation	18	21	25	28	32	20.0	18.5	9.4	17.1
Operations management	2	3	3	3	4	32.0	6.1	14.3	22.5
Support services	8	10	12	13	14	24.5	21.3	8.8	8.7
Services	**31**	**37**	**44**	**48**	**56**	**20.9**	**17.9**	**10.1**	**15.8**
Software and services	**64**	**75**	**86**	**94**	**106**	**15.8**	**14.9**	**10.2**	**12.1**
Total IT market	**210**	**219**	**243**	**262**	**288**	**4.0**	**10.9**	**8.1**	**9.7**
Switching	54	61	67	74	81	12.4	9.1	11.7	9.3
Transmission	43	49	54	60	65	13.6	9.7	11.8	9.2
Mobile communications infrastructure	88	98	108	120	132	11.1	10.4	10.9	10.1
Public network equipment	**185**	**208**	**228**	**254**	**278**	**12.1**	**9.9**	**11.3**	**9.7**
PABX and key systems	11	12	14	15	17	9.9	15.3	10.0	11.5
Telephone sets	4	5	5	6	6	8.7	14.5	8.9	10.4
Mobile terminal equipment	8	9	11	12	13	8.7	15.3	10.0	11.6
Other terminal equipment	4	5	5	6	6	8.7	16.0	9.0	10.5
Private network equipment	**28**	**31**	**35**	**39**	**43**	**9.2**	**15.3**	**9.7**	**11.2**
Telecom equipment	**213**	**238**	**263**	**293**	**321**	**11.7**	**10.6**	**11.1**	**9.9**
Telephone services	213	229	252	275	299	7.5	10.2	9.1	8.7
Mobile telephone services	50	55	61	67	74	11.1	10.4	10.6	10.2
Switched data and lease line services	11	13	15	16	17	13.6	15.2	9.4	6.6
CaTV services	3	3	4	4	5	8.7	5.6	9.4	18.9
Telecom services	**277**	**300**	**332**	**363**	**395**	**8.4**	**10.4**	**9.4**	**9.0**
Total telecom	**490**	**539**	**595**	**655**	**717**	**9.8**	**10.5**	**10.2**	**9.4**
Total ICT	**701**	**757**	**838**	**918**	**1,005**	**8.1**	**10.6**	**9.6**	**9.5**

Table 33
Slovenia
ICT market value, million ECU

Table 34
Estonia
ICT market value, million ECU

Estonia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	11	12	13	14	16	5.7	6.4	12.8	13.4
Unix servers	3	3	3	4	4	12.3	-9.8	13.7	12.2
NT servers	2	2	2	2	3	29.9	8.0	10.0	12.7
Other servers	5	5	6	7	8	-5.6	19.3	15.3	12.7
Server add-ons	1	2	1	2	2	4.9	-0.5	5.3	20.0
Workstations	1	1	1	1	1	12.7	-2.0	-0.5	5.2
PCs	33	38	43	49	53	12.4	13.2	14.4	9.6
portable	2	2	3	3	4	37.3	21.2	24.6	19.8
desktop	32	35	40	45	49	11.1	12.7	13.7	8.8
PC/workstation add-ons	10	11	12	14	15	11.4	7.9	12.7	5.8
PC printers	7	8	9	10	10	11.1	6.1	12.1	4.4
Other add-ons	3	3	4	4	5	12.2	12.5	14.2	9.1
Computer hardware	**56**	**62**	**69**	**78**	**85**	**10.9**	**10.6**	**13.6**	**9.5**
Copiers	4	4	4	5	5	-0.4	1.3	5.9	6.8
Other office equipment	2	2	2	2	2	1.9	-5.7	0.6	9.6
Office equipment	**6**	**6**	**6**	**6**	**7**	**0.3**	**-0.8**	**4.4**	**7.6**
LAN hardware	8	10	12	13	15	30.8	13.2	13.2	13.6
Other data communications	1	2	2	2	3	17.6	10.0	18.2	23.1
Data communications hardware	**9**	**12**	**13**	**15**	**17**	**28.9**	**12.8**	**13.9**	**14.9**
IT hardware	**71**	**80**	**88**	**99**	**110**	**12.3**	**10.1**	**13.0**	**10.2**
Systems software	5	7	8	9	12	46.6	18.8	18.8	23.3
Application software	5	7	10	14	20	40.6	44.4	38.5	44.4
Software products	**10**	**14**	**18**	**24**	**32**	**43.4**	**32.0**	**29.9**	**36.0**
Consulting	1	1	2	3	3	60.0	25.0	60.0	25.0
Implementation	5	7	7	11	17	43.3	4.7	55.6	50.0
Operations management	1	1	1	2	3	10.0	27.3	50.0	66.7
Support services	2	2	3	4	4	25.0	52.0	21.1	13.0
Services	**8**	**11**	**13**	**19**	**27**	**38.0**	**17.4**	**47.5**	**41.0**
Software and services	**17**	**25**	**31**	**42**	**59**	**41.0**	**25.6**	**37.2**	**38.2**
Total IT market	**89**	**105**	**119**	**142**	**168**	**17.9**	**13.7**	**19.3**	**18.6**
Switching	27	30	33	36	39	12.4	9.4	10.3	6.3
Transmission	21	24	26	29	31	13.6	10.0	10.4	7.1
Mobile communications infrastructure	43	48	53	58	63	11.1	10.7	9.5	7.3
Public network equipment	**91**	**102**	**113**	**124**	**133**	**12.1**	**10.2**	**10.0**	**7.0**
PABX and key systems	5	6	7	7	8	9.9	12.6	6.8	7.3
Telephone sets	2	2	3	3	3	8.7	11.9	5.9	6.3
Mobile terminal equipment	4	5	5	5	6	8.7	12.6	6.9	7.3
Other terminal equipment	2	2	3	3	3	8.7	13.4	5.9	6.3
Private network equipment	**14**	**15**	**17**	**18**	**19**	**9.2**	**12.6**	**6.6**	**7.0**
Telecom equipment	**105**	**117**	**130**	**142**	**152**	**11.7**	**10.5**	**9.5**	**7.0**
Telephone services	104	113	130	147	160	8.7	14.9	13.7	8.8
Mobile telephone services	25	27	32	36	40	11.1	15.7	15.3	9.7
Switched data and lease line services	6	6	8	9	9	13.6	17.4	14.0	9.1
CaTV services	2	2	2	2	3	8.7	10.1	14.0	19.0
Telecom services	**135**	**148**	**171**	**194**	**212**	**9.3**	**15.1**	**14.0**	**9.1**
Total telecom	**241**	**266**	**300**	**336**	**364**	**10.4**	**13.0**	**12.1**	**8.2**
Total ICT	**329**	**370**	**419**	**478**	**532**	**12.4**	**13.2**	**14.1**	**11.3**

Table 35
EU
ICT market value, million ECU

EU	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	19,993	21,812	23,489	25,103	26,954	9.1	7.7	6.9	7.4
Unix servers	4,598	4,936	5,460	6,000	6,580	7.3	10.6	9.9	9.7
NT servers	1,084	2,011	2,554	2,989	3,517	85.5	27.0	17.0	17.7
Other servers	6,924	6,978	7,052	7,225	7,466	0.8	1.0	2.5	3.3
Server add-ons	7,387	7,886	8,424	8,890	9,391	6.8	6.8	5.5	5.6
Workstations	2,708	2,400	2,225	2,159	2,085	-11.4	-7.3	-2.9	-3.4
PCs	26,045	28,156	29,672	31,343	33,526	8.1	5.4	5.6	7.0
portable	6,030	6,622	7,188	7,632	8,206	9.8	8.5	6.2	7.5
desktop	20,014	21,534	22,484	23,710	25,320	7.6	4.4	5.5	6.8
PC/workstation add-ons	8,652	9,354	9,856	10,316	10,752	8.1	5.4	4.7	4.2
PC printers	5,735	6,032	6,078	6,146	6,163	5.2	0.8	1.1	0.3
Other add-ons	2,917	3,322	3,777	4,170	4,589	13.9	13.7	10.4	10.0
Computer hardware	**57,397**	**61,722**	**65,242**	**68,921**	**73,317**	**7.5**	**5.7**	**5.6**	**6.4**
Copiers	5,116	5,149	5,230	5,292	5,371	0.6	1.6	1.2	1.5
Other office equipment	3,813	3,833	3,870	3,881	3,919	0.5	1.0	0.3	1.0
Office equipment	**8,929**	**8,982**	**9,100**	**9,173**	**9,290**	**0.6**	**1.3**	**0.8**	**1.3**
LAN hardware	4,102	4,908	5,729	6,336	6,772	19.7	16.7	10.6	6.9
Other data communications	1,427	1,482	1,653	1,821	1,972	3.9	11.5	10.1	8.3
Data communications hardware	**5,528**	**6,390**	**7,382**	**8,156**	**8,744**	**15.6**	**15.5**	**10.5**	**7.2**
IT hardware	**71,855**	**77,094**	**81,724**	**86,251**	**91,351**	**7.3**	**6.0**	**5.5**	**5.9**
Systems software	14,581	15,816	17,502	19,545	21,739	8.5	10.7	11.7	11.2
Application software	14,687	16,382	18,622	21,190	23,998	11.5	13.7	13.8	13.3
Software products	**29,269**	**32,198**	**36,124**	**40,735**	**45,737**	**10.0**	**12.2**	**12.8**	**12.3**
Consulting	4,870	5,513	6,513	7,587	8,729	13.2	18.1	16.5	15.0
Implementation	15,632	18,045	21,168	24,994	28,851	15.4	17.3	18.1	15.4
Operations management	17,565	19,276	21,655	24,607	27,874	9.7	12.3	13.6	13.3
Support services	13,418	13,676	14,375	15,161	15,999	1.9	5.1	5.5	5.5
Services	**51,485**	**56,510**	**63,711**	**72,349**	**81,453**	**9.8**	**12.7**	**13.6**	**12.6**
Software and services	**80,754**	**88,708**	**99,834**	**113,084**	**127,191**	**9.8**	**12.5**	**13.3**	**12.5**
Total IT market	**152,609**	**165,802**	**181,558**	**199,335**	**218,541**	**8.6**	**9.5**	**9.8**	**9.6**
Switching	6,655	6,413	6,072	5,960	5,979	- 3.6	-5.3	-1.8	0.3
Transmission	3,229	3,246	3,612	3,735	3,972	0.5	11.3	3.4	6.3
Mobile communications infrastructure	3,001	3,504	4,416	5,290	5,933	16.8	26.0	19.8	12.1
Public network equipment	**12,885**	**13,163**	**14,099**	**14,985**	**15,883**	**2.2**	**7.1**	**6.3**	**6.0**
PABX and key systems	3,046	2,994	3,038	3,086	3,153	- 1.7	1.5	1.6	2.2
Telephone sets	4,572	4,738	4,928	5,080	5,242	3.6	4.0	3.1	3.2
Mobile terminal equipment	3,386	3,669	3,861	4,078	4,335	8.4	5.3	5.6	6.3
Other terminal equipment	4,431	5,101	5,751	6,418	7,163	15.1	12.7	11.6	11.6
Private network equipment	**15,434**	**16,502**	**17,579**	**18,661**	**19,893**	**6.9**	**6.5**	**6.2**	**6.6**
Telecom equipment	**28,319**	**29,665**	**31,678**	**33,646**	**35,776**	**4.8**	**6.8**	**6.2**	**6.3**
Telephone services	91,324	94,032	97,630	101,104	104,319	3.0	3.8	3.6	3.2
Mobile telephone services	18,880	23,951	30,757	35,846	39,136	26.9	28.4	16.5	9.2
Switched data and leased line services	17,978	21,152	22,955	24,342	26,019	17.7	8.5	6.0	6.9
CaTV services	4,567	5,192	5,936	6,688	7,691	13.7	14.3	12.7	15.0
Telecom services	**132,749**	**144,326**	**157,278**	**167,981**	**177,165**	**8.7**	**9.0**	**6.8**	**5.5**
Total telecom	**161,068**	**173,991**	**188,956**	**201,627**	**212,941**	**8.0**	**8.6**	**6.7**	**5.6**
Total ICT	**313,677**	**339,792**	**370,514**	**400,962**	**431,483**	**8.3**	**9.0**	**8.2**	**7.6**

Western Europe	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	21,147	23,131	24,981	26,751	28,731	9.4	8.0	7.1	7.4
Unix servers	4,932	5,326	5,928	6,530	7,156	8.0	11.3	10.1	9.6
NT servers	1,151	2,142	2,726	3,205	3,779	86.1	27.3	17.6	17.9
Other servers	7,300	7,376	7,467	7,658	7,917	1.0	1.2	2.6	3.4
Server add-ons	7,764	8,286	8,860	9,358	9,880	6.7	6.9	5.6	5.6
Workstations	2,906	2,575	2,386	2,314	2,236	-11.4	-7.4	-3.0	-3.4
PCs	27,892	30,100	31,617	33,323	35,517	7.9	5.0	5.4	6.6
portable	6,465	7,081	7,682	8,134	8,697	9.5	8.5	5.9	6.9
desktop	21,427	23,019	23,935	25,189	26,819	7.4	4.0	5.2	6.5
PC/workstation add-ons	9,189	9,929	10,439	10,910	11,348	8.1	5.1	4.5	4.0
PC printers	6,062	6,376	6,404	6,473	6,483	5.2	0.4	1.1	0.2
Other add-ons	3,127	3,553	4,035	4,437	4,865	13.6	13.6	10.0	9.6
Computer hardware	**61,134**	**65,735**	**69,423**	**73,298**	**77,832**	**7.5**	**5.6**	**5.6**	**6.2**
Copiers	5,286	5,320	5,403	5,466	5,546	0.6	1.6	1.2	1.5
Other office equipment	4,084	4,102	4,141	4,170	4,211	0.4	1.0	0.7	1.0
Office equipment	**9,370**	**9,421**	**9,544**	**9,637**	**9,758**	**0.5**	**1.3**	**1.0**	**1.3**
LAN hardware	4,352	5,199	6,056	6,706	7,159	19.5	16.5	10.7	6.8
Other data communications	1,495	1,553	1,729	1,902	2,060	3.8	11.4	10.0	8.3
Data communications hardware	**5,848**	**6,752**	**7,785**	**8,608**	**9,219**	**15.5**	**15.3**	**10.6**	**7.1**
IT hardware	**76,352**	**81,909**	**86,752**	**91,543**	**96,809**	**7.3**	**5.9**	**5.5**	**5.8**
Systems software	15,454	16,778	18,558	20,735	23,076	8.6	10.6	11.7	11.3
Application software	15,566	17,349	19,703	22,417	25,387	11.5	13.6	13.8	13.2
Software products	**31,020**	**34,128**	**38,261**	**43,152**	**48,463**	**10.0**	**12.1**	**12.8**	**12.3**
Consulting	5,273	5,941	6,989	8,140	9,350	12.7	17.6	16.5	14.9
Implementation	16,787	19,313	22,606	26,615	30,660	15.0	17.1	17.7	15.2
Operations management	18,818	20,630	23,122	26,221	29,652	9.6	12.1	13.4	13.1
Support services	14,304	14,586	15,313	16,148	17,034	2.0	5.0	5.5	5.5
Services	**55,181**	**60,470**	**68,031**	**77,124**	**86,695**	**9.6**	**12.5**	**13.4**	**12.4**
Software and services	**86,201**	**94,598**	**106,292**	**120,276**	**135,158**	**9.7**	**12.4**	**13.2**	**12.4**
Total IT market	**162,553**	**176,506**	**193,044**	**211,819**	**231,967**	**8.6**	**9.4**	**9.7**	**9.5**
Switching	7,016	6,746	6,400	6,272	6,286	- 3.9	-5.1	-2.0	0.2
Transmission	3,610	3,637	4,032	4,163	4,417	0.8	10.8	3.2	6.1
Mobile communications infrastructure	3,129	3,638	4,560	5,445	6,100	16.3	25.3	19.4	12.0
Public network equipment	**13,755**	**14,021**	**14,992**	**15,881**	**16,802**	**1.9**	**6.9**	**5.9**	**5.8**
PABX and key systems	3,172	3,118	3,163	3,211	3,280	- 1.7	1.4	1.5	2.1
Telephone sets	4,864	5,041	5,240	5,404	5,576	3.6	4.0	3.1	3.2
Mobile terminal equipment	3,560	3,844	4,046	4,272	4,540	8.0	5.3	5.6	6.3
Other terminal equipment	4,623	5,326	6,015	6,721	7,511	15.2	12.9	11.7	11.8
Private network equipment	**16,218**	**17,329**	**18,464**	**19,608**	**20,907**	**6.8**	**6.6**	**6.2**	**6.6**
Telecom equipment	**29,974**	**31,350**	**33,456**	**35,488**	**37,709**	**4.6**	**6.7**	**6.1**	**6.3**
Telephone services	95,833	98,679	102,465	106,100	109,458	3.0	3.8	3.5	3.2
Mobile telephone services	19,902	25,217	32,319	37,602	40,986	26.7	28.2	16.3	9.0
Switched data and leased line services	19,118	22,439	24,303	25,776	27,554	17.4	8.3	6.1	6.9
CaTV services	5,059	5,747	6,543	7,362	8,443	13.6	13.8	12.5	14.7
Telecom services	**139,913**	**152,082**	**165,630**	**176,839**	**186,442**	**8.7**	**8.9**	**6.8**	**5.4**
Total telecom	**169,887**	**183,430**	**199,086**	**212,328**	**224,151**	**8.0**	**8.5**	**6.7**	**5.6**
Total ICT	**332,440**	**359,936**	**392,129**	**424,147**	**456,118**	**8.3**	**8.9**	**8.2**	**7.5**

Table 36
Western Europe
ICT market value, million ECU

Table 37
Central and Eastern Europe
ICT market value, million ECU

Central and Eastern Europe[1]	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Total server	631	769	775	879	1,003	21.8	0.8	13.5	14.1
Unix servers	210	252	249	271	284	19.8	- 1.0	8.7	4.7
NT servers	75	153	181	245	317	102.8	18.3	35.3	29.4
Other servers	248	252	242	252	273	1.9	- 4.2	4.3	8.1
Server add-ons	98	112	103	111	130	13.9	- 7.9	8.5	16.5
Workstations	59	67	71	70	75	12.6	6.0	-1.2	7.5
PCs	2,144	2,472	1,972	1,828	2,122	15.3	-20.2	-7.3	16.1
portable	256	286	239	228	256	11.8	-16.3	-4.6	12.1
desktop	1,888	2,186	1,733	1,599	1,866	15.8	-20.7	-7.7	16.7
PC/workstation add-ons	636	748	660	646	699	17.6	-11.7	-2.1	8.2
PC printers	459	554	488	475	502	20.6	-12.0	-2.6	5.7
Other add-ons	177	194	172	171	197	9.8	-11.1	-0.5	14.9
Computer hardware	**3,470**	**4,055**	**3,478**	**3,423**	**3,900**	**16.9**	**-14.2**	**-1.6**	**13.9**
Copiers	297	336	381	433	467	13.0	13.2	13.9	7.8
Other office equipment	157	156	162	169	169	-0.8	3.6	4.4	-0.1
Office equipment	**455**	**492**	**542**	**602**	**636**	**8.2**	**10.2**	**11.1**	**5.6**
LAN hardware	281	368	342	349	392	30.7	- 7.0	2.0	12.4
Other data communications	114	120	108	103	115	5.0	- 9.5	-5.0	11.2
Data communications hardware	**395**	**488**	**450**	**452**	**507**	**23.3**	**- 7.6**	**0.3**	**12.1**
IT hardware	**4,321**	**5,035**	**4,470**	**4,477**	**5,042**	**16.5**	**-11.2**	**0.2**	**12.6**
Systems software	260	297	300	315	353	14.3	1.0	4.8	12.3
Application software	356	433	473	515	582	21.5	9.2	9.0	13.1
Software products	**617**	**730**	**773**	**830**	**936**	**18.4**	**5.9**	**7.4**	**12.8**
Consulting	187	208	243	273	312	11.2	17.0	12.4	14.3
Implementation	546	642	730	793	923	17.5	13.7	8.6	16.4
Operations management	172	192	203	225	255	11.4	5.7	11.1	13.3
Support services	335	378	383	408	445	12.7	1.4	6.4	9.2
Services	**1,240**	**1,419**	**1,558**	**1,698**	**1,935**	**14.4**	**9.8**	**9.0**	**13.9**
Software and services	**1,857**	**2,149**	**2,331**	**2,528**	**2,871**	**15.7**	**8.5**	**8.4**	**13.5**
Total IT market	**6,178**	**7,184**	**6,802**	**7,006**	**7,913**	**16.3**	**- 5.3**	**3.0**	**13.0**
Switching	1,360	1,534	1,534	1,497	1,709	12.8	0.0	-2.4	14.2
Transmission	1,148	1,304	1,234	1,206	1,395	13.6	- 5.4	-2.3	15.8
Mobile communications infrastructure	2,221	2,498	2,484	2,406	2,790	12.4	- 0.5	-3.1	15.9
Public network equipment	**4,729**	**5,335**	**5,252**	**5,108**	**5,894**	**12.8**	**- 1.6**	**-2.7**	**15.4**
PABX and key systems	301	332	321	303	344	10.4	- 3.4	-5.6	13.6
Telephone sets	113	124	119	112	126	9.7	- 4.0	-6.5	12.6
Mobile terminal equipment	226	249	241	227	258	10.1	- 3.4	-5.5	13.7
Other terminal equipment	113	124	121	113	127	9.8	- 2.7	-6.5	12.6
Private network equipment	**754**	**830**	**802**	**755**	**856**	**10.1**	**- 3.4**	**-5.9**	**13.4**
Telecom equipment	**5,483**	**6,165**	**6,054**	**5,863**	**6,749**	**12.4**	**- 1.8**	**-3.2**	**15.1**
Telephone services	6,295	7,097	7,283	7,820	9,060	12.7	2.6	7.4	15.9
Mobile telephone services	1,513	1,744	1,779	1,920	2,239	15.3	2.0	8.0	16.6
Switched data and lease line services	337	383	389	418	474	13.6	1.6	7.5	13.2
CaTV services	97	108	105	113	137	10.8	- 2.7	7.5	21.5
Telecom services	**8,243**	**9,332**	**9,556**	**10,271**	**11,910**	**13.2**	**2.4**	**7.5**	**16.0**
Total telecom	**13,726**	**15,497**	**15,610**	**16,134**	**18,659**	**12.9**	**0.7**	**3.4**	**15.6**
Total ICT	**19,903**	**22,681**	**22,412**	**23,140**	**26,572**	**14.0**	**- 1.2**	**3.2**	**14.8**

[1] Czech Republic, Estonia, Hungary, Poland, Russia, Slovakia, Slovenia

Table 38
Austria
IT hardware shipments, units

Austria	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	3,819	4,150	4,548	4,659	4,492	8.7	9.6	2.4	-3.6
NT servers	2,611	4,920	6,976	7,917	9,184	88.5	41.8	13.5	16.0
Other servers	6,921	8,827	10,115	11,516	12,039	27.5	14.6	13.8	4.5
Workstations	3,406	3,474	2,934	2,654	2,472	2.0	-15.5	- 9.6	-6.8
PCs	360,346	387,882	441,064	511,838	552,870	7.6	13.7	16.0	8.0
portable	51,881	59,653	67,902	75,534	89,953	15.0	13.8	11.2	19.1
desktop	308,465	328,229	373,162	436,304	462,917	6.4	13.7	16.9	6.1
PC printers	315,169	373,445	424,607	461,548	481,394	18.5	13.7	8.7	4.3
Typewriters	17,755	14,417	11,894	9,837	8,951	-18.8	-17.5	-17.3	-9.0
Calculators	434,213	441,987	453,479	464,363	473,278	1.8	2.6	2.4	1.9
Copiers	22,834	23,413	24,162	24,966	25,690	2.5	3.2	3.3	2.9
LAN cards	170,000	205,000	236,000	256,000	338,000	20.6	15.1	8.5	32.0

Table 39
Belgium/Luxembourg
IT hardware shipments, units

Belgium/ Luxembourg	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	4,821	4,950	5,553	5,647	5,744	2.7	12.2	1.7	1.7
NT servers	3,980	7,250	9,298	10,094	10,923	82.2	28.2	8.6	8.2
Other servers	8,739	11,394	10,510	10,521	10,785	30.4	- 7.8	0.1	2.5
Workstations	5,777	5,916	5,133	4,754	4,404	2.4	-13.2	- 7.4	- 7.4
PCs	383,641	424,199	500,116	562,268	615,921	10.6	17.9	12.4	9.5
portable	64,654	82,094	101,667	115,090	116,766	27.0	23.8	13.2	1.5
desktop	318,987	342,105	398,449	447,178	499,155	7.2	16.5	12.2	11.6
PC printers	369,156	434,092	473,594	526,163	569,835	17.6	9.1	11.1	8.3
Typewriters	38,159	35,787	32,279	28,632	25,711	-6.2	- 9.8	-11.3	-10.2
Calculators	614,993	640,042	661,804	686,952	706,874	4.1	3.4	3.8	2.9
Copiers	36,612	37,439	38,974	40,728	42,032	2.3	4.1	4.5	3.2
LAN cards	300,000	384,000	454,000	545,000	593,000	28.0	18.2	20.0	8.8

Table 40
Denmark
IT hardware shipments, units

Denmark	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	2,552	2,400	2,514	2,485	2,493	- 6.0	4.8	- 1.1	0.3
NT servers	2,805	5,130	8,197	9,327	10,503	82.9	59.8	13.8	12.6
Other servers	7,324	8,805	12,216	14,295	15,435	20.2	38.7	17.0	8.0
Workstations	2,290	2,329	2,008	1,845	1,720	1.7	-13.8	- 8.1	- 6.7
PCs	439,146	444,578	486,379	467,710	473,933	1.2	9.4	- 3.8	1.3
portable	62,440	69,950	73,695	74,119	80,715	12.0	5.4	0.6	8.9
desktop	376,706	374,628	412,684	393,591	393,218	- 0.6	10.2	- 4.6	- 0.1
PC printers	322,676	382,815	383,963	396,250	407,345	18.6	0.3	3.2	2.8
Typewriters	19,863	17,178	14,515	12,004	10,539	-13.5	-15.5	-17.3	-12.2
Calculators	455,166	468,783	484,252	490,063	497,414	3.0	3.3	1.2	1.5
Copiers	25,027	26,484	27,411	28,129	28,804	5.8	3.5	2.6	2.4
LAN cards	280,000	309,000	392,000	397,000	497,000	10.4	26.9	1.3	25.2

Table 41
Finland
IT hardware shipments, units

Finland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	2,291	2,586	2,387	2,202	2,300	12.9	- 7.7	-7.7	4.4
NT servers	2,513	4,740	6,625	7,183	7,918	88.6	39.8	8.4	10.2
Other servers	5,203	7,131	7,908	8,538	8,432	37.1	10.9	8.0	-1.2
Workstations	3,619	3,733	3,165	2,883	2,694	3.2	-15.2	-8.9	-6.6
PCs	330,936	367,305	419,524	458,730	485,740	11.0	14.2	9.3	5.9
portable	42,296	48,196	58,433	67,449	71,666	13.9	21.2	15.4	6.3
desktop	288,640	319,109	361,091	391,281	414,074	10.6	13.2	8.4	5.8
PC printers	202,529	245,053	253,875	265,299	271,136	21.0	3.6	4.5	2.2
Typewriters	14,270	13,294	12,324	11,819	11,169	-6.8	- 7.3	-4.1	-5.5
Calculators	327,520	330,781	335,743	342,122	346,228	1.0	1.5	1.9	1.2
Copiers	24,636	25,429	26,777	28,035	29,241	3.2	5.3	4.7	4.3
LAN cards	267,000	288,000	362,000	400,000	416,000	7.9	25.7	10.5	4.0

Table 42
France
IT hardware shipments, units

France	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	21,477	21,800	20,329	19,589	18,940	1.5	- 6.7	- 3.6	- 3.3
NT servers	14,751	28,100	37,807	48,814	53,277	90.5	34.5	29.1	9.1
Other servers	39,756	48,093	52,735	70,111	77,272	21.0	9.7	32.9	10.2
Workstations	31,331	32,401	29,507	27,265	25,583	3.4	- 8.9	- 7.6	- 6.2
PCs	2,647,621	3,076,569	3,571,126	4,023,436	4,527,946	16.2	16.1	12.7	12.5
portable	345,565	400,752	458,355	512,684	583,031	16.0	14.4	11.9	13.7
desktop	2,302,056	2,675,817	3,112,771	3,510,752	3,944,915	16.2	16.3	12.8	12.4
PC printers	1,981,024	2,279,677	2,601,111	2,780,588	2,966,888	15.1	14.1	6.9	6.7
Typewriters	175,564	158,641	138,493	116,611	104,950	-9.6	-12.7	-15.8	-10.0
Calculators	3,656,456	3,907,665	4,177,294	4,319,322	4,474,818	6.9	6.9	3.4	3.6
Copiers	200,123	204,930	210,463	212,989	216,103	2.4	2.7	1.2	1.5
LAN cards	1,451,000	1,913,000	2,057,000	2,322,000	2,751,000	31.8	7.5	12.9	18.5

Table 43
Germany
IT hardware shipments, units

Germany	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	31,113	32,593	32,484	33,036	33,036	4.8	- 0.3	1.7	0.0
NT servers	41,758	79,047	95,212	104,448	106,015	89.3	20.4	9.7	1.5
Other servers	52,476	68,816	69,187	72,862	75,048	31.1	0.5	5.3	3.0
Workstations	52,970	53,836	50,153	48,827	46,405	1.6	- 6.8	- 2.6	- 5.0
PCs	4,117,401	4,623,911	5,513,039	6,304,456	7,075,207	12.3	19.2	14.4	12.2
portable	583,592	656,557	822,488	1,018,574	1,231,813	12.5	25.3	23.8	20.9
desktop	3,533,809	3,967,354	4,690,551	5,285,882	5,843,394	12.3	18.2	12.7	10.5
PC printers	3,980,206	4,736,096	5,200,233	5,678,655	6,030,731	19.0	9.8	9.2	6.2
Typewriters	443,993	361,261	295,943	249,879	215,895	-18.6	-18.1	-15.6	-13.6
Calculators	8,014,313	7,601,241	7,236,382	6,939,690	6,655,163	- 5.2	- 4.8	- 4.1	- 4.1
Copiers	371,153	381,545	386,887	394,624	401,333	2.8	1.4	2.0	1.7
LAN cards	2,618,000	3,342,000	3,744,000	4,315,000	5,089,000	27.7	12.0	15.3	17.9

Greece	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	913	895	838	821	811	-2.0	- 6.4	-2.1	-1.2
NT servers	571	1,080	2,036	2,227	2,409	89.3	88.5	9.4	8.2
Other servers	1,220	1,490	1,766	1,862	1,926	22.1	18.5	5.5	3.4
Workstations	1,125	1,172	1,015	923	858	4.2	-13.4	-9.1	-7.0
PCs	109,579	125,589	147,289	171,046	197,636	14.6	17.3	16.1	15.5
portable	9,079	10,915	13,971	16,905	19,609	20.2	28.0	21.0	16.0
desktop	100,500	114,674	133,318	154,141	178,027	14.1	16.3	15.6	15.5
PC printers	115,209	132,757	146,033	164,871	186,139	15.2	10.0	12.9	12.9
Typewriters	173,305	177,980	182,224	185,467	188,434	2.7	2.4	1.8	1.6
Calculators	138,292	150,587	162,634	175,807	190,048	8.9	8.0	8.1	8.1
Copiers	12,621	13,039	13,574	14,144	14,724	3.3	4.1	4.2	4.1
LAN cards	34,210	39,264	43,858	47,981	51,963	14.8	11.7	9.4	8.3

Table 44
Greece
IT hardware shipments, units

Ireland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	884	860	930	1,005	1,069	- 2.7	8.2	8.0	6.5
NT servers	1,119	1,940	3,456	4,705	5,527	73.4	78.2	36.1	17.5
Other servers	2,388	3,208	3,926	4,706	5,057	34.3	22.4	19.9	7.5
Workstations	2,538	2,597	2,159	1,891	1,697	2.3	-16.8	-12.4	-10.3
PCs	124,584	144,373	173,859	202,492	229,460	15.9	20.4	16.5	13.3
portable	17,266	21,026	26,342	31,033	35,107	21.8	25.3	17.8	13.1
desktop	107,318	123,347	147,517	171,459	194,353	14.9	19.6	16.2	13.4
PC printers	69,372	79,172	89,386	98,324	105,698	14.1	12.9	10.0	7.5
Typewriters	25,896	20,367	16,402	15,467	14,818	-21.4	-19.5	- 5.7	- 4.2
Calculators	463,462	480,263	492,749	501,126	509,645	3.6	2.6	1.7	1.7
Copiers	20,936	21,094	21,683	22,312	23,004	0.8	2.8	2.9	3.1
LAN cards	27,845	31,249	35,811	38,390	41,000	12.2	14.6	7.2	6.8

Table 45
Ireland
IT hardware shipments, units

Italy	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	11,326	11,102	10,408	9,695	9,012	-2.0	- 6.3	- 6.9	- 7.0
NT servers	9,409	17,800	20,301	20,895	21,199	89.2	14.0	2.9	1.5
Other servers	31,572	38,829	45,148	48,301	49,970	23.0	16.3	7.0	3.5
Workstations	16,483	17,129	15,640	14,731	14,368	3.9	- 8.7	- 5.8	- 2.5
PCs	1,324,794	1,521,150	1,769,097	1,942,574	2,132,588	14.8	16.3	9.8	9.8
portable	207,130	246,485	292,939	326,641	362,316	19.0	18.8	11.5	10.9
desktop	1,117,664	1,274,665	1,476,158	1,615,933	1,770,272	14.0	15.8	9.5	9.6
PC printers	1,367,074	1,627,657	1,809,955	1,940,271	2,021,763	19.1	11.2	7.2	4.2
Typewriters	118,268	107,825	94,886	73,442	66,097	-8.8	-12.0	-22.6	-10.0
Calculators	2,073,704	2,085,102	2,047,571	1,932,907	1,890,383	0.5	- 1.8	- 5.6	- 2.2
Copiers	174,910	186,829	195,797	203,174	210,828	6.8	4.8	3.8	3.8
LAN cards	692,000	835,000	1,018,000	1,200,000	1,486,000	20.7	21.9	17.9	23.8

Table 46
Italy
IT hardware shipments, units

Table 47
Netherlands
IT hardware shipments, units

Netherlands	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	6,341	6,150	6,070	5,936	5,775	- 3.0	- 1.3	- 2.2	- 2.7
NT servers	8,063	15,000	23,342	26,232	29,410	86.0	55.6	12.4	12.1
Other servers	16,496	21,079	26,412	29,139	30,422	27.8	25.3	10.3	4.4
Workstations	8,433	8,721	7,567	6,988	6,508	3.4	-13.2	- 7.6	- 6.9
PCs	1,059,930	1,117,803	1,248,595	1,362,747	1,498,092	5.5	11.7	9.1	9.9
portable	160,960	193,635	224,916	260,077	288,259	20.3	16.2	15.6	10.8
desktop	898,970	924,168	1,023,679	1,102,670	1,209,833	2.8	10.8	7.7	9.7
PC printers	658,365	786,907	865,598	966,007	1,027,831	19.5	10.0	11.6	6.4
Typewriters	69,624	50,773	36,557	31,658	28,081	-27.1	-28.0	-13.4	-11.3
Calculators	1,186,688	1,188,859	1,182,915	1,194,744	1,204,302	0.2	- 0.5	1.0	0.8
Copiers	89,008	91,384	94,217	96,949	99,373	2.7	3.1	2.9	2.5
LAN cards	786,000	949,000	1,068,000	1,245,000	1,380,000	20.7	12.5	16.6	10.8

Table 48
Norway
IT hardware shipments, units

Norway	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	2,107	2,200	2,197	2,128	2,142	4.4	- 0.1	-3.1	0.7
NT servers	3,054	5,800	8,515	9,839	10,606	89.9	46.8	15.5	7.8
Other servers	6,033	7,820	10,879	12,581	13,768	29.6	39.1	15.6	9.4
Workstations	4,195	4,288	3,707	3,389	3,136	2.2	-13.6	-8.6	-7.5
PCs	387,100	408,459	446,446	452,695	449,198	5.5	9.3	1.4	-0.8
portable	52,450	60,748	72,090	79,877	76,584	15.8	18.7	10.8	-4.1
desktop	334,650	347,711	374,356	372,818	372,614	3.9	7.7	-0.4	-0.1
PC printers	235,044	288,928	308,575	319,992	328,952	22.9	6.8	3.7	2.8
Typewriters	18,708	17,683	16,357	15,244	14,421	-5.5	- 7.5	-6.8	-5.4
Calculators	321,102	298,176	277,005	265,371	254,225	-7.1	- 7.1	-4.2	-4.2
Copiers	16,572	16,919	17,291	17,654	17,989	2.1	2.2	2.1	1.9
LAN cards	272,000	318,000	358,000	366,000	417,000	16.9	12.6	2.2	13.9

Table 49
Portugal
IT hardware shipments, units

Portugal	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	1,712	1,770	1,982	2,049	2,108	3.4	12.0	3.4	2.9
NT servers	1,363	2,145	3,761	5,641	6,420	57.4	75.4	50.0	13.8
Other servers	3,472	3,420	4,206	4,844	5,306	-1.5	23.0	15.2	9.5
Workstations	1,133	1,182	1,012	919	852	4.3	-14.4	-9.2	-7.2
PCs	157,514	175,644	211,827	242,925	271,267	11.5	20.6	14.7	11.7
portable	8,200	8,878	11,928	14,928	16,638	8.3	34.4	25.1	11.5
desktop	149,314	166,766	199,899	227,997	254,629	11.7	19.9	14.1	11.7
PC printers	59,994	65,404	70,637	76,994	83,924	9.0	8.0	9.0	9.0
Typewriters	200,969	201,572	199,153	196,564	191,650	0.3	- 1.2	-1.3	-2.5
Calculators	170,494	188,965	207,862	227,193	251,275	10.8	10.0	9.3	10.6
Copiers	16,513	17,208	18,016	18,701	19,505	4.2	4.7	3.8	4.3
LAN cards	39,435	45,743	51,735	58,771	65,706	16.0	13.1	13.6	11.8

Table 50
Spain
IT hardware shipments, units

Spain	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	7,597	6,450	6,025	5,739	5,546	-15.1	- 6.6	- 4.7	- 3.4
NT servers	5,522	10,400	14,451	16,856	18,691	88.3	38.9	16.6	10.9
Other servers	19,369	25,358	30,427	33,981	36,294	30.9	20.0	11.7	6.8
Workstations	6,813	7,216	6,163	5,668	5,379	5.9	-14.6	- 8.0	- 5.1
PCs	730,800	790,754	925,875	1,070,407	1,232,549	8.2	17.1	15.6	15.1
portable	103,020	113,362	125,769	141,112	170,928	10.0	10.9	12.2	21.1
desktop	627,780	677,392	800,106	929,295	1,061,621	7.9	18.1	16.1	14.2
PC printers	885,875	1,051,920	1,249,681	1,379,648	1,491,399	18.7	18.8	10.4	8.1
Typewriters	77,349	62,226	50,589	42,242	37,427	-19.6	-18.7	-16.5	-11.4
Calculators	1,564,653	1,613,022	1,642,056	1,656,835	1,675,060	3.1	1.8	0.9	1.1
Copiers	69,120	69,046	69,711	70,060	70,550	- 0.1	1.0	0.5	0.7
LAN cards	552,000	614,000	690,750	777,094	935,621	11.2	12.5	12.5	20.4

Table 51
Sweden
IT hardware shipments, units

Sweden	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	4,809	4,500	4,765	5,008	5,130	- 6.4	5.9	5.1	2.4
NT servers	5,048	9,400	14,515	18,203	20,112	86.2	54.4	25.4	10.5
Other servers	10,728	12,986	17,965	19,268	19,833	21.0	38.3	7.3	2.9
Workstations	13,090	13,445	11,532	10,634	9,902	2.7	-14.2	- 7.8	- 6.9
PCs	712,350	771,340	891,319	971,710	1,067,200	8.3	15.6	9.0	9.8
portable	126,120	138,781	152,027	169,232	168,894	10.0	9.5	11.3	- 0.2
desktop	586,230	632,559	739,292	802,478	898,306	7.9	16.9	8.5	11.9
PC printers	476,217	559,974	606,452	624,039	635,896	17.6	8.3	2.9	1.9
Typewriters	57,997	44,444	36,133	31,472	28,262	-23.4	-18.7	-12.9	-10.2
Calculators	1,580,803	1,802,503	1,955,715	2,096,527	2,192,967	14.0	8.5	7.2	4.6
Copiers	31,324	31,895	32,469	32,988	33,648	1.8	1.8	1.6	2.0
LAN cards	478,000	577,000	628,930	696,854	746,331	20.7	9.0	10.8	7.1

Table 52
Switzerland
IT hardware shipments, units

Switzerland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	7,586	7,950	8,652	8,856	8,677	4.8	8.8	2.4	-2.0
NT servers	5,556	9,800	15,363	20,616	23,912	76.4	56.8	34.2	16.0
Other servers	13,517	16,537	17,621	18,762	19,581	22.3	6.6	6.5	4.4
Workstations	12,046	12,368	10,893	10,206	9,624	2.7	-11.9	-6.3	-5.7
PCs	598,680	638,074	717,145	813,240	879,112	6.6	12.4	13.4	8.1
portable	130,560	138,446	148,589	161,683	169,605	6.0	7.3	8.8	4.9
desktop	468,120	499,628	568,556	651,557	709,507	6.7	13.8	14.6	8.9
PC printers	503,236	624,887	657,381	731,008	774,868	24.2	5.2	11.2	6.0
Typewriters	52,088	47,241	42,328	40,127	36,716	-9.3	-10.4	-5.2	-8.5
Calculators	783,793	802,175	831,053	875,930	903,959	2.3	3.6	5.4	3.2
Copiers	28,552	28,521	29,120	29,761	30,088	-0.1	2.1	2.2	1.1
LAN cards	271,000	329,000	380,000	471,000	593,000	21.4	15.5	23.9	25.9

Table 53
United Kingdom
IT hardware shipments, units

United Kingdom	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	22,912	20,900	21,581	20,806	21,096	- 8.8	3.3	- 3.6	1.4
NT servers	21,996	42,600	55,910	62,218	65,871	93.7	31.2	11.3	5.9
Other servers	46,696	62,611	89,452	99,324	108,363	34.1	42.9	11.0	9.1
Workstations	34,539	35,130	31,735	29,378	27,694	1.7	- 9.7	- 7.4	-5.7
PCs	3,155,450	3,412,388	4,006,485	4,547,257	5,111,114	8.1	17.4	13.5	12.4
portable	577,560	665,349	769,722	860,005	914,483	15.2	15.7	11.7	6.3
desktop	2,577,890	2,747,039	3,236,763	3,687,252	4,196,631	6.6	17.8	13.9	13.8
PC printers	2,439,678	2,950,981	3,246,079	3,570,687	3,842,059	21.0	10.0	10.0	7.6
Typewriters	209,226	180,817	155,864	138,408	125,259	-13.6	-13.8	-11.2	-9.5
Calculators	3,684,065	3,707,424	3,774,158	3,826,996	3,903,536	0.6	1.8	1.4	2.0
Copiers	174,447	179,051	184,602	190,509	195,081	2.6	3.1	3.2	2.4
LAN cards	2,517,000	3,434,000	3,811,740	4,223,408	4,823,132	36.4	11.0	10.8	14.2

Table 54
Czech Republic
IT hardware shipments, units

Czech Republic	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	1,338	1,096	1,154	1,357	1,406	-18.1	5.3	17.6	3.6
NT servers	1,691	3,952	4,575	5,539	6,874	133.7	15.8	21.1	24.1
Other servers	3,373	1,770	1,800	2,116	2,028	-47.5	1.7	17.6	-4.1
Workstations	1,125	1,429	2,005	2,609	3,122	27.0	40.3	30.1	19.7
PCs	235,588	227,287	231,700	254,970	286,400	- 3.5	1.9	10.0	12.3
portable	30,270	25,700	24,200	26,320	27,400	-15.1	-5.8	8.8	4.1
desktop	205,318	201,587	207,500	228,650	259,000	- 1.8	2.9	10.2	13.3
PC printers	227,722	217,890	219,222	236,376	264,714	- 4.3	0.6	7.8	12.0
Copiers	26,100	27,204	27,357	29,579	31,425	4.2	0.6	8.1	6.2
LAN cards	155,572	170,770	179,721	197,049	229,582	9.8	5.2	9.6	16.5

Table 55
Hungary
IT hardware shipments, units

Hungary	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	624	1,012	1,126	1,321	1,476	62.2	11.2	17.3	11.8
NT servers	1,737	2,793	4,428	6,001	7,710	60.8	58.6	35.5	28.5
Other servers	3,669	4,087	3,966	4,357	4,746	11.4	-3.0	9.9	8.9
Workstations	536	850	1,170	1,495	1,741	58.6	37.6	27.8	16.5
PCs	115,398	144,250	169,692	200,397	236,306	25.0	17.6	18.1	17.9
portable	7,190	10,500	12,600	15,120	18,144	46.0	20.0	20.0	20.0
desktop	108,208	133,750	157,092	185,277	218,162	23.6	17.5	17.9	17.7
PC printers	116,005	145,865	158,063	171,726	186,398	25.7	8.4	8.6	8.5
Copiers	17,265	18,021	19,417	20,674	22,041	4.4	7.7	6.5	6.6
LAN cards	72,334	103,470	108,304	122,341	143,605	43.0	4.7	13.0	17.4

Table 56
Poland
IT hardware shipments, units

Poland	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	1,732	2,613	2,882	3,124	3,542	50.9	10.3	8.4	13.4
NT servers	1,693	5,099	8,124	11,769	16,019	201.2	59.3	44.9	36.1
Other servers	6,105	5,571	5,907	6,389	6,305	-8.7	6.0	8.2	-1.3
Workstations	1,147	1,448	2,114	2,902	3,661	26.2	46.0	37.3	26.2
PCs	368,284	469,390	579,690	691,670	797,170	27.5	23.5	19.3	15.3
portable	22,177	26,710	35,190	43,670	51,970	20.4	31.7	24.1	19.0
desktop	346,107	442,680	544,500	648,000	745,200	27.9	23.0	19.0	15.0
PC printers	331,958	451,240	479,410	519,529	568,054	35.9	6.2	8.4	9.3
Copiers	28,915	35,392	41,676	47,866	53,671	22.4	17.8	14.9	12.1
LAN cards	237,801	324,258	411,380	513,025	619,878	36.4	26.9	24.7	20.8

Table 57
Russia
IT hardware shipments, units

Russia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	1,756	4,432	1,740	1,450	1,550	152.4	-60.7	-16.7	6.9
NT servers	5,233	16,557	10,340	9,000	11,500	21.4	-37.5	-13.0	27.8
Other servers	10,921	8,158	4,870	3,500	3,750	-25.3	-40.3	-28.1	7.1
Workstations	1,493	4,300	4,700	4,000	5,500	188.0	9.3	-14.9	37.5
PCs	1,038,728	1,374,148	848,250	604,500	852,000	32.3	-38.3	-28.7	40.9
portable	43,396	56,342	43,959	33,000	46,000	29.8	-22.0	-24.9	39.4
desktop	995,332	1,317,806	804,291	571,500	806,000	32.4	-39.0	-28.9	41.0
PC printers	548,956	964,207	753,000	733,000	854,000	75.6	-21.9	- 2.7	16.5
Copiers	137,684	195,301	130,000	120,000	145,000	41.8	-33.4	- 7.7	20.8
LAN cards	338,220	663,906	480,000	450,000	634,243	96.3	-27.7	- 6.3	40.9

Table 58
Slovakia
IT hardware shipments, units

Slovakia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	341	407	392	440	492	19.4	- 3.7	12.1	11.8
NT servers	528	672	1,091	1,539	1,941	27.2	62.5	41.0	26.1
Other servers	941	999	883	810	878	6.2	-11.6	-8.3	8.3
Workstations	369	293	409	519	604	-20.6	39.6	26.9	16.4
PCs	62,690	62,160	65,410	71,951	80,737	- 0.8	5.2	10.0	12.2
portable	7,410	7,080	7,576	8,334	9,167	- 4.5	7.0	10.0	10.0
desktop	55,280	55,080	57,834	63,617	71,570	- 0.4	5.0	10.0	12.5
PC printers	62,250	63,635	64,900	67,804	73,248	2.2	2.0	4.5	8.0
Copiers	9,268	10,166	10,082	10,936	11,716	9.7	- 0.8	8.5	7.1
LAN cards	36,766	40,299	43,603	50,932	60,279	9.6	8.2	16.8	18.4

Table 59
Slovenia
IT hardware shipments, units

Slovenia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	141	119	124	153	193	-15.6	4.0	23.8	26.0
NT servers	521	657	901	1,284	1,726	26.0	37.2	42.5	34.5
Other servers	951	1,012	1,104	1,103	1,117	6.4	9.1	-0.1	1.2
Workstations	244	307	394	483	558	25.8	28.3	22.6	15.5
PCs	53,820	57,673	65,308	71,998	80,820	7.2	13.2	10.2	12.3
portable	4,230	3,920	4,567	5,183	5,987	- 7.3	16.5	13.5	15.5
desktop	49,590	53,753	60,741	66,815	74,833	8.4	13.0	10.0	12.0
PC printers	45,835	48,905	53,812	59,091	67,163	6.7	10.0	9.8	13.7
Copiers	6,306	5,936	6,497	6,848	7,193	- 5.9	9.5	5.4	5.0
LAN cards	28,602	33,622	42,638	51,167	61,249	17.6	26.8	20.0	19.7

Table 60
Estonia
IT hardware shipments, units

Estonia	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	89	104	94	110	126	17.6	-9.8	16.5	15.0
NT servers	316	452	525	611	703	43.4	16.0	16.5	15.0
Other servers	582	603	727	847	973	3.7	20.5	16.5	15.0
Workstations	126	142	150	165	176	12.7	5.6	10.0	6.7
PCs	32,620	39,200	44,000	51,200	57,450	20.2	12.2	16.4	12.2
portable	1,305	1,803	2,200	2,867	3,504	38.2	22.0	30.3	22.2
desktop	31,315	37,397	41,800	48,333	53,946	19.4	11.8	15.6	11.6
PC printers	22,508	26,264	28,600	33,280	35,619	16.7	8.9	16.4	7.0
Copiers	3,305	3,507	3,724	4,026	4,360	6.1	6.2	8.1	8.3
LAN cards	–	–	–	–	–	–	–	–	–

Table 61
EU
IT hardware shipments, units

EU	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	122,567	121,106	120,414	118,676	117,551	- 1.2	- 0.6	- 1.4	-0.9
NT servers	121,507	229,552	301,887	344,761	367,459	88.9	31.5	14.2	6.6
Other servers	252,361	322,047	381,972	429,269	456,181	27.6	18.6	12.4	6.3
Workstations	183,546	188,280	169,723	159,360	150,537	2.6	- 9.9	- 6.1	-5.5
PCs	15,654,092	17,383,484	20,305,592	22,839,595	25,471,525	11.0	16.8	12.5	11.5
portable	2,359,763	2,715,633	3,200,153	3,683,382	4,150,179	15.1	17.8	15.1	12.7
desktop	13,294,329	14,667,851	17,105,439	19,156,213	21,321,346	10.3	16.6	12.0	11.3
PC printers	13,242,544	15,705,951	17,421,204	18,929,345	20,122,039	18.6	10.9	8.7	6.3
Typewriters	1,642,238	1,446,581	1,277,258	1,143,502	1,057,244	-11.9	-11.7	-10.5	-7.5
Calculators	24,364,823	24,607,226	24,814,614	24,854,648	24,970,990	1.0	0.8	0.2	0.5
Copiers	1,269,265	1,308,787	1,344,743	1,378,309	1,409,916	3.1	2.7	2.5	2.3
LAN cards	10,212,490	12,966,256	14,593,825	16,522,498	19,213,754	27.0	12.6	13.2	16.3

Western Europe	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	132,259	131,256	131,263	129,660	128,370	- 0.8	0.0	- 1.2	-1.0
NT servers	130,118	245,152	325,765	375,215	401,978	88.4	32.9	15.2	7.1
Other servers	271,911	346,404	410,472	460,612	489,530	27.4	18.5	12.2	6.3
Workstations	199,788	204,937	184,323	172,955	163,297	2.6	-10.1	- 6.2	-5.6
PCs	16,639,872	18,430,015	21,469,181	24,105,531	26,799,836	10.8	16.5	12.3	11.2
portable	2,542,773	2,914,826	3,420,831	3,924,943	4,396,369	14.6	17.4	14.7	12.0
desktop	14,097,099	15,515,189	18,048,350	20,180,588	22,403,467	10.1	16.3	11.8	11.0
PC printers	13,980,824	16,619,766	18,387,160	19,980,345	21,225,859	18.9	10.6	8.7	6.2
Typewriters	1,713,034	1,511,505	1,335,943	1,198,873	1,108,382	-11.8	-11.6	-10.3	-7.5
Calculators	25,469,719	25,707,576	25,922,673	25,995,948	26,129,175	0.9	0.8	0.3	0.5
Copiers	1,314,390	1,354,227	1,391,154	1,425,724	1,457,994	3.0	2.7	2.5	2.3
LAN cards	10,755,490	13,613,256	15,331,825	17,359,498	20,223,754	26.6	12.6	13.2	16.5

Table 62
Western Europe
IT hardware shipments, units

Central and Eastern Europe[1]	1996	1997	1998	1999	2000	1997/96 %	1998/97 %	1999/98 %	2000/99 %
Unix servers	6,021	9,783	7,512	7,955	8,786	62.5	-23.2	5.9	10.4
NT servers	11,719	30,182	29,985	35,743	46,473	157.6	- 0.7	19.2	30.0
Other servers	26,542	22,201	19,257	19,120	19,796	-16.4	-13.3	-0.7	3.5
Workstations	5,040	8,769	10,942	12,173	15,362	74.0	24.8	11.3	26.2
PCs	1,907,128	2,374,108	2,004,050	1,946,686	2,390,883	24.5	-15.6	-2.9	22.8
portable	115,978	132,055	130,292	134,494	162,172	13.9	- 1.3	3.2	20.6
desktop	1,791,150	2,242,053	1,873,758	1,812,192	2,228,711	25.2	-16.4	-3.3	23.0
PC printers	1,355,234	1,918,006	1,757,007	1,820,806	2,049,196	41.5	- 8.4	3.6	12.5
Copiers	228,843	295,527	238,753	239,929	275,406	29.1	-19.2	0.5	14.8
LAN cards	869,295	1,336,325	1,265,646	1,384,514	1,748,836	53.7	- 5.3	9.4	26.3

[1] Note: Central and Eastern Europe excludes BU, RO, UKR, CRO, FRY, Albania, LV, LIT.

Table 63
Central and
Eastern Europe
IT hardware shipments, units

8. ICT trade flows

The data presented on trade are based upon the Combined Nomenclature, an international standard for such data. Details concerning the product categories included are given at the end of the statistical outlook. In general terms, the trade data can be considered to match well but not exactly with the classification used for IT and telecommunications hardware throughout the statistical outlook. Data processing equipment, electronic office equipment and components and related spares are all included. Semiconductor devices and other electronic components are not included.

Figures are presented in current ECU, according to standard valuation rules. Imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting Member State (fob). Data availability for this exercise has been governed by the framework of the European Commission's statistical systems which now includes EU countries only.

The term intra-EU refers to trade between Member States. Extra-EU trade is that between a Member State and a non-Member State. It should be noted that intra-EU import statistics are based upon the country of consignment, and not necessarily on the country of origin.

Table 64
Austria
Trade in ICT hardware, thousand ECU

Austria	1995	1996	1997
Imports intra-EU	1,370,502	1,452,872	1,663,840
Imports extra-EU	456,486	449,985	464,324
Imports total	1,826,988	1,902,857	2,128,164
Exports intra-EU	299,148	274,241	430,553
Exports extra-EU	355,304	331,075	533,342
Exports total	654,452	605,316	963,895
Extra-EU/intra-EU exports	118.8%	120.7%	123.9%
Extra-EU/intra-EU imports	33.3%	31.0%	27.9%
Trade balance	-1,172,536	-1,297,541	-1,164,269
Extra-EU trade balance	- 101,182	- 118,911	69,019

Table 65
Belgium/Luxembourg
Trade in ICT hardware, thousand ECU

Belgium/Luxembourg	1995	1996	1997
Imports intra-EU	2,377,669	2,965,418	3,316,674
Imports extra-EU	872,183	880,897	982,379
Imports total	3,249,851	3,846,315	4,299,053
Exports intra-EU	1,734,824	2,197,556	2,349,305
Exports extra-EU	845,708	804,164	951,088
Exports total	2,580,532	3,001,719	3,300,392
Extra-EU/intra-EU exports	48.7%	36.6%	40.5%
Extra-EU/intra-EU imports	36.7%	29.7%	29.6%
Trade balance	-669,320	-844,595	-998,661
Extra-EU trade balance	- 26,475	- 76,733	- 31,291

Table 66
Denmark
Trade in ICT hardware, thousand ECU

Denmark	1995	1996	1997
Imports intra-EU	1,542,801	1,618,698	1,954,594
Imports extra-EU	425,742	475,695	483,909
Imports total	1,968,543	2,094,393	2,438,503
Exports intra-EU	504,154	594,526	760,522
Exports extra-EU	269,445	249,393	328,371
Exports total	773,599	843,918	1,088,893
Extra-EU/intra-EU exports	53.4%	41.9%	43.2%
Extra-EU/intra-EU imports	27.6%	29.4%	24.8%
Trade balance	-1,194,943	-1,250,474	-1,349,610
Extra-EU trade balance	- 156,297	- 226,302	- 155,538

Table 67
Finland
Trade in ICT hardware, thousand ECU

Finland	1995	1996	1997
Imports intra-EU	835,749	943,100	1,177,015
Imports extra-EU	538,350	447,182	505,135
Imports total	1,374,099	1,390,282	1,682,150
Exports intra-EU	946,091	1,022,634	1,356,657
Exports extra-EU	681,463	870,949	1,295,477
Exports total	1,627,553	1,893,583	2,652,134
Extra-EU/intra-EU exports	72.0%	85.2%	95.5%
Extra-EU/intra-EU imports	64.4%	47.4%	42.9%
Trade balance	253,455	503,301	969,984
Extra-EU trade balance	143,113	423,766	790,342

Table 68
France
Trade in ICT hardware, thousand ECU

France	1995	1996	1997
Imports intra-EU	6,533,932	7,073,838	7,793,050
Imports extra-EU	4,585,949	5,038,439	5,968,750
Imports total	11,119,881	12,112,277	13,761,800
Exports intra-EU	6,024,790	6,907,383	7,872,411
Exports extra-EU	2,649,307	2,917,827	3,209,301
Exports total	8,674,096	9,825,210	11,081,712
Extra-EU/intra-EU exports	44.0%	42.2%	40.8%
Extra-EU/intra-EU imports	70.2%	71.2%	76.6%
Trade balance	−2,445,785	−2,287,067	−2,680,088
Extra-EU trade balance	−1,936,642	−2,120,612	−2,759,449

Table 69
Germany
Trade in ICT hardware, thousand ECU

Germany	1995	1996	1997
Imports intra-EU	8,307,693	7,883,661	8,702,423
Imports extra-EU	10,245,156	9,622,203	11,477,967
Imports total	18,552,849	17,505,864	20,180,389
Exports intra-EU	7,330,322	7,310,234	8,403,202
Exports extra-EU	5,171,753	5,276,665	6,009,547
Exports total	12,502,074	12,586,899	14,412,748
Extra-EU/intra-EU exports	70.6%	72.2%	71.5%
Extra-EU/intra-EU imports	123.3%	122.1%	131.9%
Trade balance	−6,050,775	−4,918,965	−5,767,641
Extra-EU trade balance	−5,073,404	−4,345,539	−5,468,420

Greece	1995	1996	1997
Imports intra-EU	374,208	345,773	465,822
Imports extra-EU	105,415	108,561	135,339
Imports total	479,623	454,334	601,160
Exports intra-EU	35,078	19,963	16,716
Exports extra-EU	20,417	28,284	51,007
Exports total	55,495	48,247	67,724
Extra-EU/intra-EU exports	58.2%	141.7%	305.1%
Extra-EU/intra-EU imports	28.2%	31.4%	29.1%
Trade balance	-424,128	-406,087	-533,436
Extra-EU trade balance	- 84,998	- 80,277	- 84,331

Table 70
Greece
Trade in ICT hardware, thousand ECU

Ireland	1995	1996	1997
Imports intra-EU	1,201,035	1,436,944	2,042,791
Imports extra-EU	2,942,843	2,955,694	3,426,017
Imports total	4,143,878	4,392,639	5,468,808
Exports intra-EU	5,667,386	6,205,610	8,279,892
Exports extra-EU	1,797,309	2,309,150	3,246,343
Exports total	7,464,696	8,514,760	11,526,235
Extra-EU/intra-EU exports	31.7%	37.2%	39.2%
Extra-EU/intra-EU imports	245.0%	205.7%	167.7%
Trade balance	3,320,818	4,122,121	6,057,427
Extra-EU trade balance	-1,145,534	-646,545	-179,673

Table 71
Ireland
Trade in ICT hardware, thousand ECU

Italy	1995	1996	1997
Imports intra-EU	4,098,351	4,747,728	5,574,666
Imports extra-EU	1,743,065	1,990,737	1,945,368
Imports total	5,841,416	6,738,465	7,520,034
Exports intra-EU	3,191,337	3,428,687	3,369,094
Exports extra-EU	1,597,102	1,332,610	1,479,634
Exports total	4,788,438	4,761,296	4,848,729
Extra-EU/intra-EU exports	50.0%	38.9%	43.9%
Extra-EU/intra-EU imports	42.5%	41.9%	34.9%
Trade balance	-1,052,978	-1,977,169	-2,671,305
Extra-EU trade balance	- 145,963	- 658,128	- 465,734

Table 72
Italy
Trade in ICT hardware, thousand ECU

Table 73
Netherlands
Trade in ICT hardware, thousand ECU

Netherlands	1995	1996	1997
Imports intra-EU	5,603,904	6,623,548	9,501,595
Imports extra-EU	6,552,897	8,006,341	11,588,939
Imports total	12,156,801	14,629,889	21,090,534
Exports intra-EU	10,526,760	11,695,537	18,772,268
Exports extra-EU	1,535,309	1,769,991	2,243,554
Exports total	12,062,068	13,465,528	21,015,823
Extra-EU/intra-EU exports	14.6%	15.1%	12.0%
Extra-EU/intra-EU imports	116.9%	120.9%	122.0%
Trade balance	- 94,733	-1,164,361	- 74,711
Extra-EU trade balance	-5,017,588	-6,236,350	-9,345,385

Table 74
Portugal
Trade in ICT hardware, thousand ECU

Portugal	1995	1996	1997
Imports intra-EU	637,632	986,742	851,702
Imports extra-EU	114,153	170,063	146,900
Imports total	751,786	1,156,804	998,602
Exports intra-EU	61,548	63,270	92,870
Exports extra-EU	13,405	17,364	25,903
Exports total	74,954	80,635	118,773
Extra-EU/intra-EU exports	21.8%	27.4%	27.9%
Extra-EU/intra-EU imports	17.9%	17.2%	17.2%
Trade balance	-676,832	-1,076,169	-879,829
Extra-EU trade balance	-100,748	- 152,699	-120,997

Table 75
Spain
Trade in ICT hardware, thousand ECU

Spain	1995	1996	1997
Imports intra-EU	2,278,626	2,804,449	3,073,231
Imports extra-EU	1,075,696	1,162,091	1,052,410
Imports total	3,354,322	3,966,539	4,125,641
Exports intra-EU	698,973	848,830	931,105
Exports extra-EU	822,873	923,732	864,286
Exports total	1,521,846	1,772,562	1,795,391
Extra-EU/intra-EU exports	117.7%	108.8%	92.8%
Extra-EU/intra-EU imports	47.2%	41.4%	34.2%
Trade balance	-1,832,476	-2,193,977	-2,330,250
Extra-EU trade balance	- 252,823	- 238,358	- 188,124

Sweden	1995	1996	1997
Imports intra-EU	2,150,316	2,394,216	2,698,752
Imports extra-EU	886,904	893,633	970,146
Imports total	3,037,221	3,287,849	3,668,899
Exports intra-EU	809,563	1,015,309	1,104,755
Exports extra-EU	1,327,672	1,489,389	1,794,795
Exports total	2,137,235	2,504,698	2,899,550
Extra-EU/intra-EU exports	164.0%	146.7%	162.5%
Extra-EU/intra-EU imports	41.2%	37.3%	35.9%
Trade balance	- 899,986	-783,151	-769,349
Extra-EU trade balance	440,767	595,756	824,648

Table 76
Sweden
Trade in ICT hardware, thousand ECU

United Kingdom	1995	1996	1997
Imports intra-EU	7,758,613	8,142,886	10,311,653
Imports extra-EU	9,069,755	10,350,017	13,688,145
Imports total	16,828,368	18,492,903	23,999,798
Exports intra-EU	10,426,364	11,423,052	15,186,814
Exports extra-EU	5,283,127	6,042,498	7,757,717
Exports total	15,709,491	17,465,549	22,944,532
Extra-EU/intra-EU exports	50.7%	52.9%	51.1%
Extra-EU/intra-EU imports	116.9%	127.1%	132.7%
Trade balance	-1,118,877	-1,027,354	-1,055,267
Extra-EU trade balance	-3,786,629	-4,307,520	-5,930,428

Table 77
UK
Trade in ICT hardware, thousand ECU

EU	1995	1996	1997
Imports intra-EU	40,714,464	49,419,872	59,127,807
Imports extra-EU	37,732,855	42,551,539	52,835,728
Imports total	78,447,319	91,971,411	111,963,535
Exports intra-EU	46,201,535	53,006,832	68,926,164
Exports extra-EU	20,005,755	24,363,089	29,790,366
Exports total	66,207,290	77,369,921	98,716,530
Extra-EU/intra-EU exports	43.3%	46.0%	43.2%
Extra-EU/intra-EU imports	92.7%	86.1%	89.4%
Trade balance	-12,240,029	-14,601,490	-13,247,004
Extra-EU trade balance	-17,727,101	-18,188,450	-23,045,362

Table 78
EU
Trade in ICT hardware, thousand ECU

9. Market structures and penetration of ICT

The different markets in Europe certainly have features in common, but equally the degree of variation amongst the countries is also considerable. The tables which follow attempt to illustrate the degree to which Western European countries distinguished in terms of their competitive fabric, and overall use of IT and telecommunications.

The market share of a leader in a particular market is, for the purposes of this study, a composite measure. For the hardware market it is obtained by considering the top leaders position in each of the hardware products segment to assess the degree to which the market leaders in various related sectors (from high-end servers to personal computers) dominate this market. The software and services markets are here defined in terms which stress their independent structures. For software the market share of a leader is obtained by considering the relative position of software suppliers for whom software revenue is identifiable. For services it is obtained on the basis of services revenue as identified and released by the players. Consequently the leader market share information is not sensitive to the balance of power between the traditional hardware suppliers and the independent specialists.

The figure on market concentration is based on the cumulative market share (measured on total IT revenue) of the top ten IT vendors, in each year, with the composition of the top ten varying each year.

Austria		1995	1996	1997
Industry leader's share	Hardware	15.5%	14.4%	11.9%
	Software	6.9%	7.9%	12.4%
	Services	1.8%	1.8%	2.2%
Industry concentration (top 10 vendors)	Total IT	66.3%	67.9%	72.9%
Market comparisons	IT market versus GDP	1.90%	1.96%	2.08%
	Per capita IT expenditure (ECU)	406	425	463
	ICT market versus GDP	3.62%	3.87%	4.13%
	Per capita ICT expenditure (ECU)	772	842	921

Table 79
Austria
Market structures and penetration of ICT

Belgium/Luxembourg		1995	1996	1997
Industry leader's share	Hardware	16.4%	16.6%	11.5%
	Software	3.6%	3.9%	7.0%
	Services	4.3%	5.4%	6.5%
Industry concentration (top 10 vendors)	Total IT	40.0%	37.8%	38.8%
Market comparisons	IT market versus GDP	2.15%	2.22%	2.38%
	Per capita IT expenditure (ECU)	422	448	495
	ICT market versus GDP	4.21%	4.53%	4.82%
	Per capita ICT expenditure (ECU)	825	913	1,004

Table 80
Belgium/Luxembourg
Market structures and penetration of ICT

Denmark		1995	1996	1997
Industry leader's share	Hardware	18.2%	21.7%	16.7%
	Software	8.1%	7.8%	13.7%
	Services	5.0%	5.5%	6.3%
Industry concentration (top 10 vendors)	Total IT	61.2%	58.9%	61.2%
Market comparisons	IT market versus GDP	2.75%	2.86%	2.96%
	Per capita IT expenditure (ECU)	686	737	803
	ICT market versus GDP	4.95%	5.20%	5.36%
	Per capita ICT expenditure (ECU)	1,234	1,340	1,454

Table 81
Denmark
Market structures and penetration of ICT

Table 82
Finland
Market structures and penetration of ICT

Finland		1995	1996	1997
Industry leader's share	Hardware	15.1%	17.7%	8.6%
	Software	8.3%	7.3%	12.9%
	Services	11.0%	13.9%	15.3%
Industry concentration (top 10 vendors)	Total IT	67.7%	76.8%	79.7%
Market comparisons	IT market versus GDP	2.37%	2.49%	2.64%
	Per capita IT expenditure (ECU)	433	471	520
	ICT market versus GDP	4.68%	4.97%	5.21%
	Per capita ICT expenditure (ECU)	857	942	1,026

Table 83
France
Market structures and penetration of ICT

France		1995	1996	1997
Industry leader's share	Hardware	19.6%	13.9%	12.5%
	Software	7.4%	7.4%	11.5%
	Services	4.7%	4.0%	5.2%
Industry concentration (top 10 vendors)	Total IT	32.5%	30.5%	32.8%
Market comparisons	IT market versus GDP	2.31%	2.40%	2.51%
	Per capita IT expenditure (ECU)	460	488	526
	ICT market versus GDP	4.35%	4.50%	4.73%
	Per capita ICT expenditure (ECU)	866	917	991

Table 84
Germany
Market structures and penetration of ICT

Germany		1995	1996	1997
Industry leader's share	Hardware	10.6%	11.0%	10.8%
	Software	6.5%	5.2%	8.9%
	Services	4.5%	4.4%	5.1%
Industry concentration (top 10 vendors)	Total IT	38.8%	38.0%	40.1%
Market comparisons	IT market versus GDP	2.10%	2.05%	2.13%
	Per capita IT expenditure (ECU)	451	460	492
	ICT market versus GDP	4.30%	4.18%	4.31%
	Per capita ICT expenditure (ECU)	924	939	996

Table 85
Italy
Market structures and penetration of ICT

Italy		1995	1996	1997
Industry leader's share	Hardware	25.2%	16.9%	21.7%
	Software	5.0%	7.0%	12.8%
	Services	9.1%	10.0%	13.0%
Industry concentration (top 10 vendors)	Total IT	51.9%	49.5%	53.8%
Market comparisons	IT market versus GDP	1.48%	1.44%	1.45%
	Per capita IT expenditure (ECU)	241	252	268
	ICT market versus GDP	3.65%	3.66%	3.77%
	Per capita ICT expenditure (ECU)	595	642	697

Table 86
Netherlands
Market structures and penetration of ICT

Netherlands		1995	1996	1997
Industry leader's share	Hardware	20.8%	17.3%	15.1%
	Software	3.1%	3.0%	4.2%
	Services	12.5%	16.3%	19.6%
Industry concentration (top 10 vendors)	Total IT	49.1%	45.0%	45.8%
Market comparisons	IT market versus GDP	2.65%	2.78%	2.92%
	Per capita IT expenditure (ECU)	490	527	578
	ICT market versus GDP	5.09%	5.45%	5.75%
	Per capita ICT expenditure (ECU)	943	1,034	1,136

Table 87
Norway
Market structures and penetration of ICT

Norway		1995	1996	1997
Industry leader's share	Hardware	14.5%	15.0%	12.6%
	Software	10.5%	10.1%	13.9%
	Services	3.0%	4.3%	4.9%
Industry concentration (top 10 vendors)	Total IT	58.1%	67.8%	71.8%
Market comparisons	IT market versus GDP	2.48%	2.52%	2.65%
	Per capita IT expenditure (ECU)	658	711	778
	ICT market versus GDP	4.63%	4.81%	4.97%
	Per capita ICT expenditure (ECU)	1,230	1,357	1,460

Table 88
Spain
Market structures and penetration of ICT

Spain		1995	1996	1997
Industry leader's share	Hardware	14.9%	13.9%	14.3%
	Software	16.9%	18.1%	19.1%
	Services	8.6%	7.0%	9.1%
Industry concentration (top 10 vendors)	Total IT	47.6%	44.2%	46.3%
Market comparisons	IT market versus GDP	1.30%	1.34%	1.41%
	Per capita IT expenditure (ECU)	141	152	168
	ICT market versus GDP	3.39%	3.69%	3.82%
	Per capita ICT expenditure (ECU)	366	419	455

Table 89
Sweden
Market structures and penetration of ICT

Sweden		1995	1996	1997
Industry leader's share	Hardware	20.9%	13.5%	10.1%
	Software	20.7%	23.7%	24.9%
	Services	7.5%	7.9%	9.1%
Industry concentration (top 10 vendors)	Total IT	46.0%	49.5%	50.3%
Market comparisons	IT market versus GDP	3.28%	3.35%	3.45%
	Per capita IT expenditure (ECU)	702	733	782
	ICT market versus GDP	5.88%	6.03%	6.20%
	Per capita ICT expenditure (ECU)	1,256	1,320	1,404

Table 90
Switzerland
Market structures and penetration of ICT

Switzerland		1995	1996	1997
Industry leader's share	Hardware	19.6%	16.2%	10.0%
	Software	6.7%	7.1%	11.4%
	Services	1.4%	1.4%	1.7%
Industry concentration (top 10 vendors)	Total IT	35.1%	35.9%	38.3%
Market comparisons	IT market versus GDP	2.88%	3.04%	3.19%
	Per capita IT expenditure (ECU)	900	956	1,012
	ICT market versus GDP	5.43%	5.70%	6.02%
	Per capita ICT expenditure (ECU)	1,694	1,793	1,906

United Kingdom		1995	1996	1997
Industry leader's share	Hardware	16.9%	13.3%	8.9%
	Software	4.8%	5.8%	8.5%
	Services	4.9%	5.7%	7.1%
Industry concentration (top 10 vendors)	Total IT	35.4%	36.4%	37.2%
Market comparisons	IT market versus GDP	3.11%	3.22%	3.36%
	Per capita IT expenditure (ECU)	530	573	627
	ICT market versus GDP	5.73%	6.05%	6.22%
	Per capita ICT expenditure (ECU)	978	1,077	1,163

Table 91
United Kingdom market structures and penetration of ICT

	1995	1996	1997	1998
Austria	406	425	463	501
Belgium/Luxemb.	422	448	495	544
Denmark	686	737	803	868
Finland	433	471	520	568
France	460	488	526	575
Germany	451	460	492	536
Greece	70	75	84	93
Ireland	282	303	333	368
Italy	241	252	268	290
Netherlands	490	527	578	626
Norway	658	711	778	842
Portugal	105	115	128	141
Spain	141	152	168	184
Sweden	702	733	782	858
Switzerland	900	956	1,012	1,070
UK	530	573	627	687
Western Europe	400	424	460	502
US	879	978	1,075	1,166
Japan	646	710	745	713

	1995	1996	1997	1998
Austria	1.90	1.96	2.08	2.17
Belgium/Luxemb.	2.15	2.22	2.38	2.51
Denmark	2.75	2.86	2.96	3.08
Finland	2.37	2.49	2.64	2.67
France	2.31	2.40	2.51	2.65
Germany	2.10	2.05	2.13	2.24
Greece	0.87	0.86	0.88	0.91
Ireland	2.01	2.01	2.05	1.99
Italy	1.48	1.44	1.45	1.51
Netherlands	2.65	2.78	2.92	3.01
Norway	2.48	2.52	2.65	2.86
Portugal	1.32	1.35	1.41	1.45
Spain	1.30	1.34	1.41	1.45
Sweden	3.28	3.35	3.45	3.66
Switzerland	2.88	3.04	3.19	3.32
UK	3.11	3.22	3.36	3.51
Western Europe	2.22	2.25	2.34	2.45
US	3.97	4.26	4.53	4.70
Japan	2.30	2.53	2.61	2.43

Table 92
Per capita IT expenditure, ECU (left)

Table 93
IT % GDP (right)

Table 94
Per capita telecommunications expenditure, ECU (left)

Table 95
Telecommunications % GDP (right)

	1995	1996	1997	1998
Austria	366	417	458	495
Belgium/Luxemb.	403	465	509	555
Denmark	548	603	651	686
Finland	424	470	505	551
France	405	429	465	508
Germany	474	479	503	528
Greece	226	265	307	359
Ireland	469	547	608	682
Italy	353	390	429	492
Netherlands	452	508	558	607
Norway	572	646	682	728
Portugal	244	264	303	337
Spain	225	267	287	314
Sweden	554	587	622	662
Switzerland	795	838	894	953
UK	448	504	536	563
Western Europe	408	443	478	518
US	619	652	684	724
Japan	551	573	591	574

	1995	1996	1997	1998
Austria	1.72	1.92	2.05	2.15
Belgium/Luxemb.	2.06	2.31	2.44	2.56
Denmark	2.20	2.34	2.40	2.44
Finland	2.32	2.48	2.57	2.59
France	2.04	2.11	2.22	2.34
Germany	2.20	2.13	2.18	2.21
Greece	2.83	3.04	3.22	3.51
Ireland	3.34	3.62	3.73	3.69
Italy	2.17	2.22	2.32	2.55
Netherlands	2.44	2.68	2.82	2.92
Norway	2.15	2.29	2.32	2.47
Portugal	3.06	3.11	3.34	3.47
Spain	2.09	2.35	2.41	2.48
Sweden	2.59	2.68	2.75	2.83
Switzerland	2.54	2.66	2.82	2.96
UK	2.63	2.83	2.87	2.88
Western Europe	2.27	2.35	2.44	2.53
US	2.79	2.84	2.89	2.92
Japan	1.96	2.04	2.07	1.96

Table 96
Per capita ICT expenditure, ECU (left)

Table 97
ICT % GDP (right)

	1995	1996	1997	1998
Austria	772	842	921	996
Belgium/Luxemb.	825	913	1,004	1,098
Denmark	1,234	1,340	1,454	1,554
Finland	857	942	1,026	1,119
France	866	917	991	1,083
Germany	924	939	996	1,064
Greece	295	340	391	452
Ireland	751	850	942	1,049
Italy	595	642	697	782
Netherlands	943	1,034	1,136	1,233
Norway	1,230	1,357	1,460	1,570
Portugal	349	379	432	477
Spain	366	419	455	497
Sweden	1,256	1,320	1,404	1,520
Switzerland	1,694	1,793	1,906	2,023
UK	978	1,077	1,163	1,250
Western Europe	808	867	938	1,020
US	1,498	1,630	1,759	1,890
Japan	1,196	1,283	1,337	1,287

	1995	1996	1997	1998
Austria	3.62	3.87	4.13	4.32
Belgium/Luxemb.	4.21	4.53	4.82	5.08
Denmark	4.95	5.20	5.36	5.52
Finland	4.68	4.97	5.21	5.26
France	4.35	4.50	4.73	5.00
Germany	4.30	4.18	4.31	4.45
Greece	3.70	3.90	4.09	4.42
Ireland	5.35	5.63	5.78	5.68
Italy	3.65	3.66	3.77	4.06
Netherlands	5.09	5.45	5.75	5.93
Norway	4.63	4.81	4.97	5.33
Portugal	4.38	4.46	4.76	4.92
Spain	3.39	3.69	3.82	3.93
Sweden	5.88	6.03	6.20	6.49
Switzerland	5.43	5.70	6.02	6.28
UK	5.73	6.05	6.22	6.39
Western Europe	4.49	4.61	4.78	4.98
US	6.76	7.11	7.42	7.62
Japan	4.25	4.56	4.68	4.39

10. Price dynamics

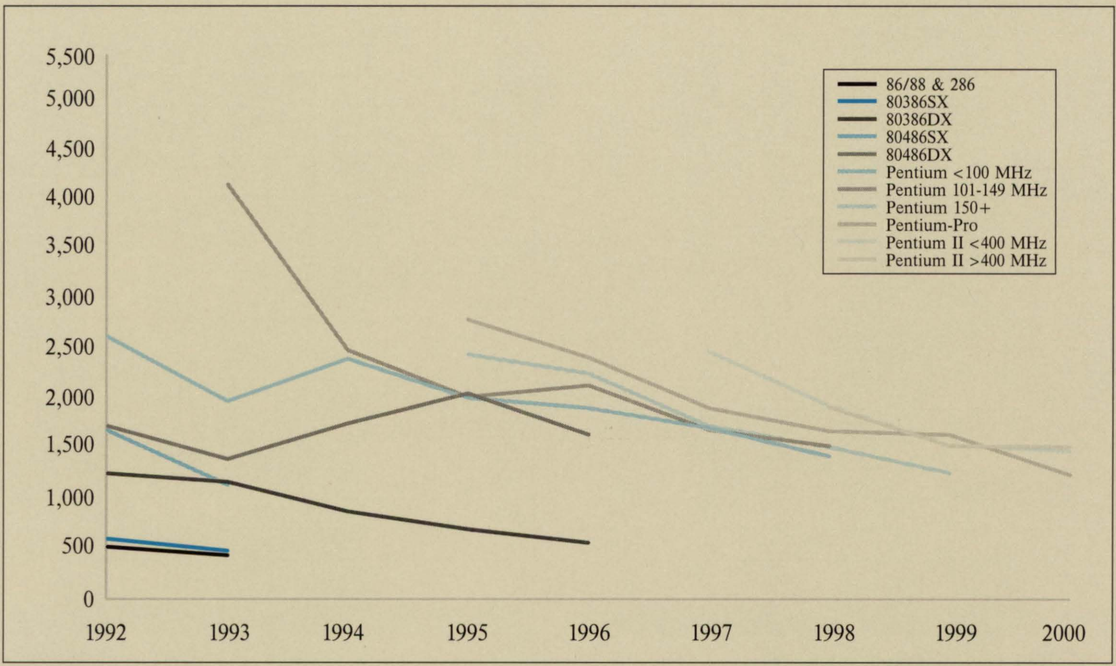


Figure 13
Evolution of average selling prices for PCs, US, ECU, 1992–2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000
86/88 & 286	528	443							
80386SX	604	485							
80386DX	1,268	1,183	885	706	570				
80486SX	1,694	1,149							
80486DX	1,745	1,413	1,772	2,075	1,661				
Pentium <100 MHz	2,639	1,992	2,420	2,025	1,924	1,725	1,438		
Pentium 101-149 MHz		4,179	2,511	2,039	2,156	1,709	1,545		
Pentium 150+				2,464	2,273	1,743	1,532	1,271	
Pentium-Pro				2,818	2,437	1,928	1,696	1,660	1,255
Pentium II <400 MHz						2,495	1,947	1,552	1,491
Pentium II >400 MHz							1,938	1,548	1,537

Table 98
Evolution of average selling prices for PCs, US (ECU exchange rates 1997), 1992–2000

Figure 14
Convergence of average selling prices for Pentium > 150 MHz, US versus Europe, ECU, 1995–1999

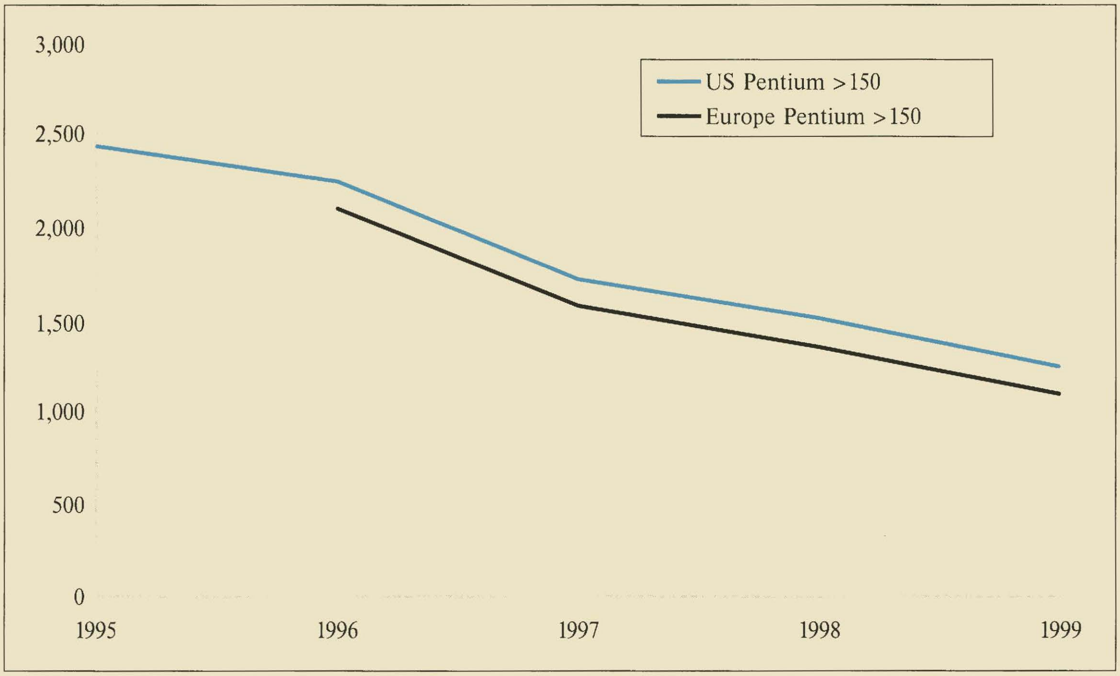
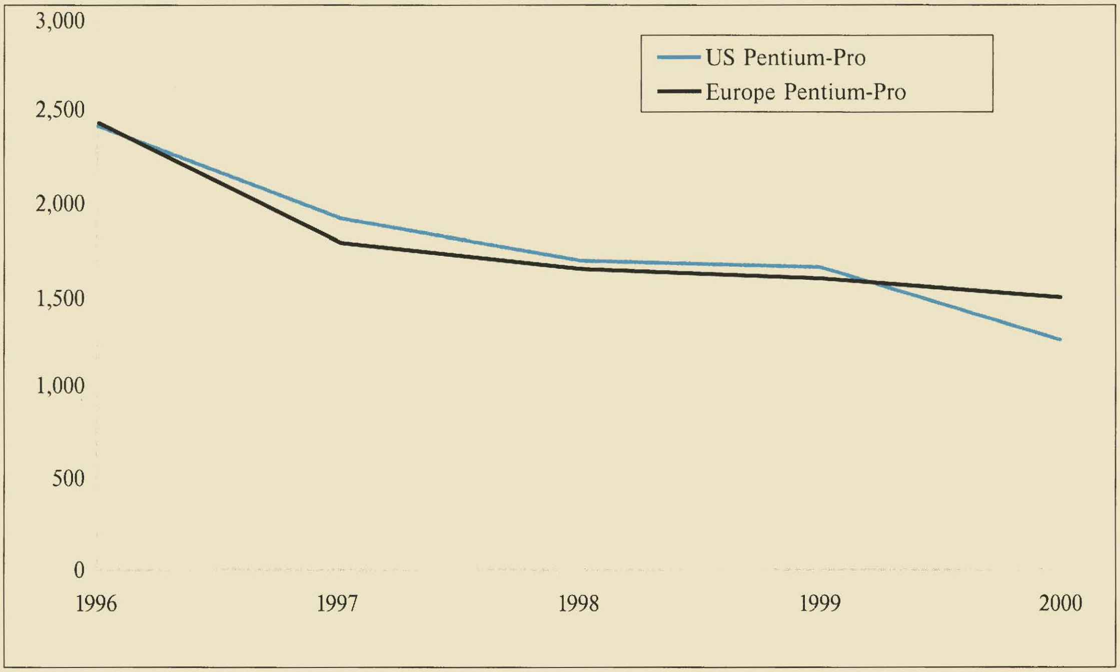


Figure 15
Convergence of average selling prices for Pentium-Pro, US versus Europe, ECU, 1996–2000



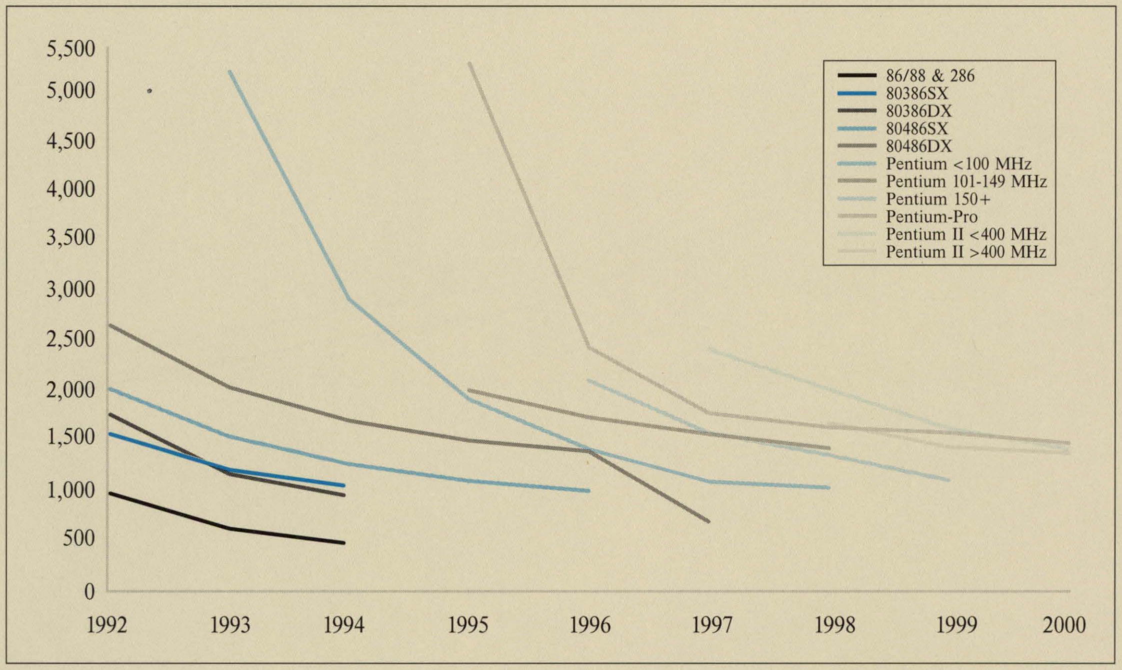
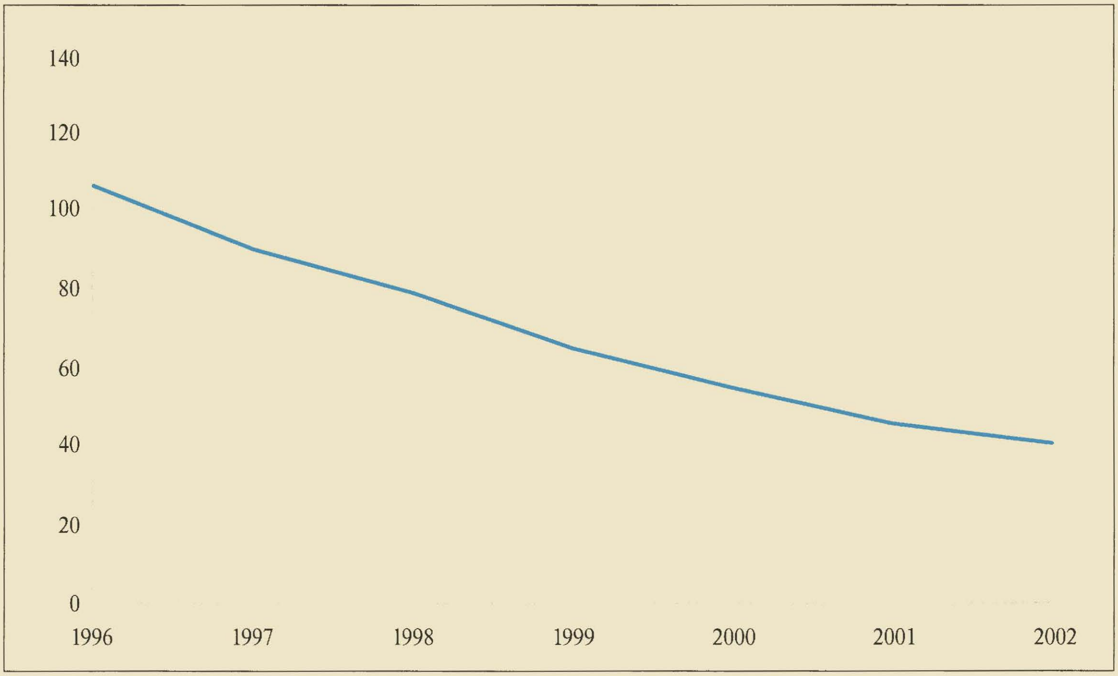


Figure 16
Evolution of average selling prices for PCs, Europe, ECU, 1992–2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000
86/88 & 286	984	629	485						
80386SX	1,587	1,227	1,068						
80386DX	1,778	1,179	967						
80486SX	2,040	1,561	1,285	1,115	1,014				
80486DX	2,674	2,052	1,717	1,516	1,407	700			
Pentium <100 MHz		5,235	2,944	1,938	1,436	1,107	1,047		
Pentium 101-149 MHz				2,023	1,750	1,581	1,438		
Pentium 150+					2,126	1,599	1,376	1,123	
Pentium-Pro				5,313	2,453	1,793	1,650	1,596	1,490
Pentium II <400 MHz						2,441	2,038	1,646	1,436
Pentium II >400 MHz							1,694	1,450	1,391

Table 99
Evolution of average selling prices for PCs, Europe, ECU exchange rates 1997, 1992–2000

Figure 17
Evolution of average selling price for PC Network Interface Card, Western Europe, ECU, 1996–2002



Appendix

Table 100
Main lines, thousands

Main lines	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	33,733	34,272	34,813	35,438	36,152	36,856	1.8
Germany	45,334	46,448	47,531	48,675	49,829	50,507	2.2
Italy	25,612	26,548	27,432	28,755	30,300	31,565	4.3
Spain	15,854	16,391	17,072	17,813	18,586	19,437	4.2
UK	31,597	32,585	33,500	34,343	35,018	35,677	2.5
Rest of Western Europe[1]	65,255	67,962	70,625	73,129	75,532	77,838	3.6
Western Europe	**217,386**	**224,206**	**230,972**	**238,153**	**245,418**	**251,880**	**3.0**
Eastern Europe[2]	70,144	75,099	79,998	85,215	90,259	95,252	6.3
Total Europe	**287,530**	**299,305**	**310,970**	**323,367**	**335,677**	**347,132**	**3.8**
USA	175,996	182,616	190,370	197,655	204,472	210,826	3.7
Japan	63,300	64,566	65,986	67,702	69,259	70,714	2.2
Rest of World	270,257	305,925	341,212	378,467	416,533	453,523	10.9
World	**797,083**	**852,411**	**908,538**	**967,191**	**1,025,941**	**1,082,195**	**6.3**

Source: EITO Task Force

[1] Incl. Turkey
[2] Geographical demarkation

Table 101
Digital main lines, thousands

Digital main lines	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	33,733	34,272	34,813	35,438	36,152	36,856	1.8
Germany	45,334	46,448	47,531	48,675	49,829	50,507	2.2
Italy	23,947	26,123	27,350	28,755	30,300	31,565	5.7
Spain	12,795	14,404	16,098	17,794	18,586	19,437	8.7
UK	30,649	32,422	33,500	34,343	35,018	35,677	3.1
Rest of Western Europe[1]	54,505	61,224	66,548	70,776	73,536	76,176	6.9
Western Europe	**200,962**	**214,893**	**225,839**	**235,780**	**243,422**	**250,218**	**4.5**
Eastern Europe[2]	20,207	26,349	32,937	39,864	46,855	53,967	21.7
Total Europe	**221,169**	**241,242**	**258,776**	**275,644**	**290,277**	**304,185**	**6.6**
USA	153,993	166,902	179,927	192,242	201,451	209,265	6.3
Japan	63,300	64,566	65,986	67,702	69,259	70,714	2.2
Rest of World	235,714	277,524	318,284	360,666	402,804	441,366	13.4
World	**674,177**	**750,234**	**822,974**	**896,253**	**963,791**	**1,025,529**	**8.8**

Source: EITO Task Force

[1] Incl. Turkey
[2] Geographical demarkation

Table 102
ISDN equivalent lines, thousands

ISDN equivalent lines	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	2,157	3,878	5,697	7,002	7,829	8,744	32.3
Germany	7,461	11,049	12,933	14,825	16,756	17,688	18.8
Italy	795	1,425	2,234	3,067	3,800	4,537	41.7
Spain	575	746	924	1,070	1,235	1,400	19.5
UK	2,615	3,859	5,179	6,516	7,543	8,585	26.8
Rest of Western Europe[1]	2,739	4,702	6,737	8,986	11,250	13,303	37.2
Western Europe	**16,343**	**25,658**	**33,705**	**41,466**	**48,413**	**54,257**	**27.1**
Eastern Europe[2]	62	135	275	502	937	1,812	96.4
Total Europe	**16,405**	**25,793**	**33,980**	**41,969**	**49,349**	**56,069**	**27.9**
USA	5,186	7,050	9,158	11,288	13,376	15,196	24.0
Japan	4,923	6,762	9,366	11,945	14,286	16,425	27.2
Rest of World	942	1,901	3,382	5,931	8,961	12,748	68.4
World	**27,456**	**41,507**	**55,886**	**71,132**	**85,973**	**100,438**	**29.6**

[1] Incl. Turkey
[2] Geographical demarkation

Source: EITO Task Force

Table 103
Total mobile telephone subscribers, thousands

Total mobile telephone subscribers	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	5,792	10,500	15,000	18,900	22,400	25,600	34.6
Germany	8,252	13,800	20,000	25,800	31,300	36,300	34.5
Italy	11,730	20,000	27,000	31,000	34,400	37,200	26.0
Spain	4,337	6,300	8,700	11,200	13,500	15,500	29.0
UK	8,344	11,300	14,700	18,000	21,200	24,300	23.8
Rest of Western Europe[1]	18,334	28,222	37,310	45,687	53,020	59,266	26.4
Western Europe	**56,789**	**90,122**	**122,710**	**150,587**	**175,820**	**198,166**	**28.4**
Eastern Europe[2]	3,808	7,791	12,037	16,476	21,236	26,148	47.0
Total Europe	**60,597**	**97,913**	**134,747**	**167,063**	**197,056**	**224,314**	**29.9**
USA	54,718	66,500	81,000	97,000	112,000	126,500	18.2
Japan	28,746	40,000	50,000	58,000	64,000	69,000	19.1
Rest of World	61,840	99,967	136,480	173,838	211,065	247,898	32.0
World	**205,901**	**304,380**	**402,227**	**495,901**	**584,121**	**667,712**	**26.5**

[1] Incl. Turkey
[2] Geographical demarkation

Source: EITO Task Force

Analogue mobile telephone subscribers	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	167	50	0	0	0	0	-100.0
Germany	476	350	250	170	110	50	- 36.3
Italy	3,370	3,300	2,800	2,300	1,900	1,500	- 14.9
Spain	1,100	800	600	500	400	300	- 22.9
UK	1,765	1,100	600	300	150	70	- 47.6
Rest of Western Europe[1]	2,897	2,244	1,813	1,422	1,078	824	- 22.2
Western Europe	**9,775**	**7,844**	**6,063**	**4,692**	**3,638**	**2,744**	**- 22.4**
Eastern Europe[2]	901	1,108	1,210	1,314	1,430	1,552	11.5
Total Europe	**10,676**	**8,952**	**7,273**	**6,006**	**5,068**	**4,296**	**- 16.6**
USA	47,718	48,500	47,000	44,000	39,000	33,000	- 7.1
Japan	1,974	900	500	200	0	0	-100.0
Rest of World	31,946	36,214	36,764	35,548	33,828	31,663	- 0.2
World	**92,314**	**94,566**	**91,537**	**85,754**	**77,896**	**68,959**	**- 5.7**

Source: EITO Task Force

Table 104
Analogue mobile telephone subscribers, thousands

[1] Incl. Turkey
[2] Geographical demarkation

Digital mobile telephone subscribers	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	5,625	10,450	15,000	18,900	22,400	25,600	35.4
Germany	7,776	13,450	19,750	25,630	31,190	36,250	36.1
Italy	8,360	16,700	24,200	28,700	32,500	35,700	33.7
Spain	3,237	5,500	8,100	10,700	13,100	15,200	36.3
UK	6,579	10,200	14,100	17,700	21,050	24,230	29.8
Rest of Western Europe[1]	15,437	25,978	35,497	44,265	51,942	58,442	30.5
Western Europe	**47,014**	**82,278**	**116,647**	**145,895**	**172,182**	**195,422**	**33.0**
Eastern Europe[2]	2,907	6,683	10,827	15,162	19,806	24,596	53.3
Total Europe	**49,921**	**88,961**	**127,474**	**161,057**	**191,988**	**220,018**	**34.5**
USA	7,000	18,000	34,000	53,000	73,000	93,500	67.9
Japan	26,772	39,100	49,500	57,800	64,000	69,000	20.8
Rest of World	29,894	63,754	99,716	138,290	177,237	216,235	48.5
World	**113,587**	**209,815**	**310,690**	**410,147**	**506,225**	**598,753**	**39.4**

Source: EITO Task Force

Table 105
Digital mobile telephone subscribers, thousands

[1] Incl. Turkey
[2] Geographical demarkation

Table 106
Total cable TV subscribers, thousands

Total cable TV subscribers	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	2,299	2,531	2,750	3,003	3,230	3,461	8.5
Germany	18,500	19,200	19,900	20,500	21,100	21,700	3.2
Italy	52	160	280	407	540	686	67.5
Spain	1,641	1,749	1,950	2,112	2,230	2,369	7.6
UK	2,403	2,704	2,990	3,278	3,550	3,823	9.7
Rest of Western Europe[1]	19,045	19,542	20,063	20,840	21,356	21,831	2.8
Western Europe	**43,940**	**45,886**	**47,933**	**50,140**	**52,006**	**53,870**	**4.2**
Eastern Europe[2]	11,914	13,004	13,920	14,918	15,709	16,490	6.7
Total Europe	**55,854**	**58,890**	**61,852**	**65,058**	**67,715**	**70,360**	**4.7**
USA	64,640	64,963	65,288	65,614	65,680	65,746	0.3
Japan	4,290	5,910	8,000	10,200	12,290	14,310	27.2
Rest of World	84,779	96,588	108,045	119,031	129,752	140,620	10.7
World	**209,563**	**226,351**	**243,185**	**259,903**	**275,437**	**291,035**	**6.8**

[1] Incl. Turkey
[2] Geographical demarkation

Source: EITO Task Force

Table 107
Internet/online users, thousands

Internet/online users	1997	1998	1999	2000	2001	2002	CAGR in % 1997/2002
France	7,038	7,541	8,175	10,118	12,491	15,153	16.6
Germany	5,529	7,295	9,426	12,621	16,299	19,907	29.2
Italy	680	1,108	2,300	3,300	4,200	5,300	50.8
Spain	853	1,106	1,453	1,780	2,528	3,426	32.1
UK	6,198	8,110	10,222	12,254	14,120	15,983	20.9
Rest of Western Europe[1]	6,241	8,746	11,607	14,651	18,133	21,686	28.3
Western Europe	**26,539**	**33,906**	**43,183**	**54,723**	**67,771**	**81,456**	**25.1**
Eastern Europe[2]	2,068	3,147	4,758	6,723	9,114	11,868	41.8
Total Europe	**28,607**	**37,053**	**47,941**	**61,446**	**76,885**	**93,324**	**26.7**
USA	58,395	72,547	83,338	94,790	106,230	117,870	15.1
Japan	7,377	9,827	13,741	18,996	24,455	30,369	32.7
Rest of World	18,922	28,795	40,471	55,228	71,084	86,231	35.4
World	**113,301**	**148,222**	**185,491**	**230,460**	**278,653**	**327,793**	**23.7**

[1] Incl. Turkey
[2] Geographical demarkation

Source: EITO Task Force

Table 108
Penetration

Penetration 1997	Inhabitants (inhab.) (000)	Households (HH) (000)	Main lines (ML) (000)	ML per 100 inh. (%)	Digital ML on ML (%)	CaTV subscribers (000)	CaTV subscribers/HH (%)	Mobile subscribers (000)	Mobile subscribers/inhabitants (%)	Internet/online users (000)	Internet/online users/100 inhab. (%)
Austria	8,090	3,096	4,013	49.6	79.4	1,080	34.9	1,164	14.4	480	5.9
Belgium	10,190	4,120	4,769	46.8	77.9	3,650	88.6	983	9.6	403	4.0
Denmark	5,280	2,403	3,320	62.9	85.4	1,040	43.3	1,489	28.2	540	10.2
Finland	5,130	2,130	2,860	55.8	100.0	832	39.1	2,148	41.9	521	10.2
France	58,500	23,545	33,733	57.7	100.0	2,299	9.8	5,792	9.9	7,038	12.0
Germany	82,200	37,339	45,334	55.2	100.0	18,500	49.5	8,252	10.0	5,529	6.7
Greece	10,500	3,624	5,430	51.7	47.4	3	0.1	975	9.3	110	1.0
Ireland	3,600	1,192	1,460	40.6	87.5	585	49.1	510	14.2	157	4.4
Italy	57,380	20,482	25,612	44.6	93.5	52	0.3	11,730	20.4	680	1.2
Luxembourg	413	145	280	67.7	100.0	134	92.2	67	16.2	31	7.4
Netherlands	15,700	6,489	8,864	56.5	86.8	5,787	89.2	1,690	10.8	826	5.3
Norway	4,400	2,035	2,680	60.9	100.0	729	35.8	1,685	38.3	532	12.1
Portugal	9,910	3,295	4,002	40.4	88.0	371	11.3	1,507	15.2	216	2.2
Spain	39,280	12,160	15,854	40.4	80.7	1,641	13.5	4,337	11.0	853	2.2
Sweden	8,900	4,078	6,100	68.5	99.0	1,935	47.5	3,187	35.8	1,230	13.8
Switzerland	7,100	3,007	4,700	66.2	91.4	2,390	79.5	1,044	14.7	606	8.5
UK	58,900	24,600	31,597	53.6	97.0	2,403	9.8	8,344	14.2	6,198	10.5
Western Europe[1]	**451,494**	**168,388**	**217,386**	**48.1**	**92.4**	**43,940**	**26.1**	**56,789**	**12.6**	**26,539**	**5.9**
Bulgaria	8,419	2,935	2,690	32.0	7.9	200	6.8	53	0.6	9	0.1
Czech Rep.	10,300	4,038	3,277	31.8	50.0	880	21.8	524	5.1	164	1.6
Hungary	10,174	3,987	3,100	30.5	77.4	1,240	31.1	703	6.9	147	1.4
Poland	38,662	12,693	7,300	18.9	46.6	3,000	23.6	832	2.2	687	1.8
Romania	22,551	7,473	3,616	16.0	31.8	2,580	34.5	209	0.9	25	0.1

Source: EITO Task Force

[1] Incl. Turkey

11. Definitions

The statistical section of the EITO is based upon a set of definitions and methodologies agreed between the EITO Task Force and IDC, and upon the European Union standards for trade statistics. To better reflect and measure the latest trends in the ICT industry the EITO has undergone some changes in the methodology and definitions of some segments compared to past editions. All definitions are outlined below.

Geographic coverage

The heading European Union (EU) refers to Austria, Belgium and Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, the Republic of Ireland, the Netherlands, Portugal, Spain, Sweden and the UK. Non-EU is represented by data on Norway and Switzerland. Western Europe includes both the European Union states and Norway and Switzerland. Nordic includes Denmark, Finland, Norway and Sweden.

Throughout the statistical section Central and Eastern Europe is considered to refer to the Czech Republic, Hungary, Poland, Russia, Slovakia, Slovenia and Estonia. Eastern Europe also includes the following countries in aggregate format: Bulgaria, Romania, Ukraina, Croazia, Former Yugoslavia, Albania, Latvia, Lithuania.

The Four Tigers refer to Hong Kong, Korea, Singapore and Taiwan.

Information technology (IT)

For the purposes of this study information technology refers to the combined industries of hardware for office machines, data processing equipment, data communications equipment and of software and services.

Information and communications technologies (ICT)

For the purposes of this study information and communications technologies refers to information technology plus telecommunications equipment and telecommunications services.

All market values are converted from national currencies at 1997 exchange rates of those currencies against the ECU for all the years of the historical and the forecast period. Trade data are reported in *current* ECU.

Domestic markets

Domestic market value reflects the revenues paid to primary vendors and the value-added across the distribution channels for sale to the final customer for office machines, DP systems, software and/or services. For product-specific definitions, see other terms below.

Unit shipments are the unit measure of hardware product sales by vendors to all distribution channels or to end-users. Units are counted as they leave suppliers and are not double-counted in the case of Original Equipment Manufacturer (OEM) relationships.

IT user budgets are investigated in IT user surveys. As these measure purchase intentions and behaviours that vary according to different geographic and time parameters, growth rates of IT user budgets do not match with growth rates of market values.

11.1. Information technology

11.1.1. IT hardware

Computer hardware

Server systems include CPU(s) and basic peripherals (e.g. data storage devices, terminals, memory and peripherals), as well as revenue for new systems added to the installed base. Multiprocessor configurations are counted as single systems. In the 1999 edition of the EITO, server systems value is reported in the two major components of server and add-ons.

Server systems is a classification used to group all computer systems except personal computers and workstations. "Servers" designates servers or hosts as sold in their initial configuration, with frame or cabinet and all cables, processors (including replacement or upgrade processors), initial memory and memory embedded in replacement or upgrade processors, initial storage, bundled communications boards, and bundled operating systems software. The classification is based on operating systems:

- *Unix servers*: all servers running the Unix operating system or variant;
- *NT servers*: all servers running Windows NT;
- *Other servers*: all IBM S390 servers, AS/400 servers, Digital Open VMS, Netware servers, PC servers not running Unix or NT.
- *Server add-ons* include:

  Add-on storage representing any storage devices shipped for use on a high-end, midrange, or low-end server subsequent to the acquisition and installation of the server.

  Printers: all printers primarily associated with hosts or exclusively with a server.

  Other server add-ons: primarily terminals (interactive non-programmable display devices) and memory upgrades acquired separately from an initial system shipment or processor upgrade.

Workstations: workstations include all traditional workstations. Personal workstations (based on Windows NT platforms) are included in the PC segment. Traditional single-user workstations have Unix or Open VMS operating system usually bundled by the hardware manufacturer, with an emphasis on technical, graphics application segments and higher levels of functionality in many areas (graphics performance, floating point, memory, disk storage).

Personal computers (PCs) are general purpose, single-user, microprocessor-based machines that are capable of supporting attached peripherals and can be programmed in a high level language. Board-level products are excluded. For microprocessor-based systems that can support more than one user, the distinction between a small-scale system and a personal computer is based on the system's most common configuration. If a system is designed as a server or is multi-microprocessor-based, it is classified as a small-scale system.

- *Portables:* portable and transportable machines are included in this category, but electronic organisers (such as the Psion Organiser products) are not counted. Subcategories acknowledged include AC-portables, battery-operated laptops, notebooks and sub-notebooks. Small hand-held products such as high-end organisers and palmtops are excluded from the portable definition.
- *Desktops:* desktop and tower machines are included in this category, but dedicated games machines (such as Nintendo) are not included. This category also includes personal workstations, combining Windows NT platforms, the economics of PCs, and emphasis on networked business/professional applications, with equivalent or slightly greater functionality than a PC's.

PC printers include models designed to be attached to PCs, not sold with the systems. These include dot matrix printers, thermal/thermal transfer printers, non-impact page printers, ink-jet printers and colour printers.

Other PC add-ons represents expenditure on PC hardware products not normally acquired in a typical initial purchase and not included in other categories. It includes memory upgrades, replacement or upgrade monitors and keyboards, and various board-level enhancements for terminal emulation, facsimile transmission, graphics enhancement, sound production.

Office equipment

Office equipment includes:

Copiers: personal, digital, and colour copiers;

Other office equipment: typewriters (mechanical, electric, electronic), calculators (professional desktop, pocket), duplicating equipment (offsets, ink duplicators), cash-registers and point-of-sale systems, document filing (microfilm, WORM optical disks), other products (franking, addressing, labelling machines, mail handling systems, etc.).

Data communications hardware

Data communications hardware includes the LAN hardware and other data communications equipment markets.

LAN hardware is restricted to the equipment for multi-user systems, PCs, or workstations required to implement a local area network; it does not include software (e.g. specialised network operation systems) or servers, which are counted in their respective software and system categories. For this project, LAN connections that come bundled with a system and/or integrated on the mother board (e.g. Ethernet in workstations) are excluded to avoid double counting with the value of systems shipments.

The LAN hardware category includes LAN interfaces, intelligent LAN concentrators, terminal servers, LAN hubs, internetwork equipment, repeaters.

- *LAN interfaces:* three categories are tracked here: LAN cards, workstation network interfaces and multi-user interfaces. Value is normally assigned on a per-node basis and includes both new networks and nodes shipped into existing LANs.
- *Intelligent LAN concentrators:* for this project are hardware devices that act as central points for star wiring for the nodes attached to the LAN and additionally provide network management functionality over the physical layer.
- *Terminal servers* provide terminal connectivity to the LAN.
- *LAN hubs*
- *Internetwork equipment* includes bridges and routers.

Other *data communications hardware* is for this project expressly limited to hardware and to the following categories, of which it is the sum: modems, digital switching equipment, communications processors and channel extenders.

- *Modems* tracked are restricted to analogue and short haul modems, segmented into dial-up and leased line segments and by speed (14.4, 16.8-19.2, 1,200, 4,800 and 9,600 bps); not counted are fibre optic, satellite, pocket, or broadband modems or digital-over-voice (DOV) products.
- *Multiplexers* are devices used to multiplex telecommunications circuits, using time-division and statistical time-division technology. Seven market segments are tracked: time-division multiplexers, point-to-point T-1 TDMs, networking T-1 TDMs, T-3 multiplexers (aggregates of 28 DS-1 circuits), and statistical TDMs; not addressed are coaxial or frequency division multiplexers or digital access cross-connect systems.
- *Packet switching equipment* includes all packet switch nodes to route data packets via the most efficient available path and PADS (Packet assemblers/disassemblers) to convert asynchronous and/or synchronous data to the relevant protocol format (e.g. X.25).

- *Digital switching equipment* includes matrix switches (designed to provide local and remote patching, switching and diagnostic functions, typically installed in data processing centres with two or more front-end processors) and data PBXs used to connect terminals to computer ports (increasingly obsolescent due to competition from front-end processors and local area networks).
- *Communications processors* are specialised and customised data communication devices that serve as nodal points for communications between IBM-compatible hosts and other nodes on a network. The classical communications processor was a front-end processor configured to function solely as the interface between an SNA host and a cluster controller attached to 3270 terminals or PCs emulating terminals. Alternatives include remote processors configured as nodes in an SNA network and gateway processors configured to translate and/or route network protocols between SNA and non-SNA nodes.
- *Cluster controllers* are devices designed to control the I/O operations of a group of 3270-type devices, including displays and printers.
- *Channel extenders* are devices that extend the distance over which an I/O channel on a single IBM mainframe can communicate with an IBM-compatible peripheral or another IBM mainframe.

The above computer, office, and telecommunications equipment definitions refer to what the EITO Task Force classifies as general-purpose products. This equipment can be used for a variety of applications in a variety of industries.

In addition to these general purpose products, information technology is also used in a wide range of application-specific devices. These include, but are not limited to: retail point-of-sale systems, automatic teller machines, credit authorisation terminals, smart-card readers, factory data collection systems, numerical controllers for manufacturing equipment, cheque processing equipment, computer-assisted publishing systems, and specialised systems for the military, aerospace and other industries. Taken together these markets are significant.

Readers should keep these definition issues in mind when working with this volume and other statistical sources. Figures from IT companies, industry research firms and institutions, trade associations, and governments may well include a mix of general purpose and application-specific equipment, complicating attempts to make direct comparisons with the published EITO figures.

11.1.2. Software products

Software products are commercially available packaged programmes for sale or lease from systems services and independent software vendors (ISVs). Value includes the packaged software fees plus related non-consulting revenue, such as fees for maintenance and/or support. This definition does not include consulting or system integration revenue or specially designed application software solutions added by turnkey systems houses (including VARs) to systems acquired from a hardware manufacturer or other third party. The primary categories are 1) systems software and utilities, 2) application tools, and 3) application solutions.

Also, for this project the software products category includes licence fees partially earmarked for software maintenance, services, and/or support; other forms of software support would be counted within the support services category.

- *Systems software* includes system infrastructure software, as well as application tools. *System infrastructure software* is divided into four primary categories. System management software is used to manage the full range of computing resources for the enterprise. Middleware is defined as independent system software and services that distributed businesses use to share computing resources across heterogeneous technologies. Serverware delivers capabilities to coordinate resources between distributed servers or nodes on the network. System-level software is the foundation of system software products that collectively operate the hardware platforms and communications networks upon which business applications are built. System-level software includes operating systems and subsystems, networking software and services, and system utilities. *Application tools* include information access tools and programmer development tools. Programmer development tools are products that support the professional developer in the design, development and implementation of a variety of software systems and solutions. Examples include database engines, 4GL, AMD (analysis, modelling and design) and 3GLs.

- *Application software* includes consumer, commercial and technical programmes designed to provide packaged software solutions for specific problems inherent in the home, industry or in a business function. Such software can address consumer applications, „cross-industry“ applications (e.g. accounting, human resource management, payroll, project management or word processing and other office activities) or specific industry applications for vertical markets (e.g. banking/financial, manufacturing, health care, oil and gas exploration, etc.).

11.1.3. Services

Consulting: encompass a broad array of IT-related planning and design activities that assist clients in making IT-related decisions on business direction or information technology. IT-related business consulting includes corporate strategy assistance, process improvement, capacity planning, best practices, business process reengineering, and change management services for business; not included are consulting involving tax, audit, benefits, financial and/or engineering issues. IT consulting includes: information systems strategy assistance, information system and network planning architectural and supplier assessments, product consulting and technical designs for information technology, and maintenance planning.

Implementation: comprise all activities directly involved with the creation of technical and business IT solutions, specifically with procuring, configuring, installing, developing, moving, testing and managing information technology. Implementation services also include all activities involved with custom application development and work performed on packaged applications. Training and education is also included in this segment. It includes activities required for the transmission of new behaviours, skills or actions that can be used to begin performing job-specific tasks or improved performance in IT-related functions.

Operations Management: involves taking responsibility for managing components of a client's IT infrastructure. Specific activities include help-desk services, asset management services, systems management, network management, software update management, facilities management, back up and archiving and business recovery services. Processing services are also included under this category.

Support Services: include all activities involved with ensuring that hardware, software and networking products are performing properly as a service to clients. Activities include all maintenance contracts for hardware, software and networking products, as well as services such as telephone support to resolve problems for clients and help with workarounds. Services in this category can come as a bundled package of other services or stand-alone.

11.2. Telecommunications

11.2.1. Telecommunications equipment

The market is classified according to the nature of the user:

Public network equipment

This segment includes all equipment used by carriers to provide voice/data network services.

Switching: local and junction switches, trunk switches, telex switches, data switches, cellular radio switches.

Transmission: multiplexers, microwave, cross connects, line terminals.

Mobile communications infrastructure: all types of equipment and systems used by PTOs in the build-up of their mobile telecommunications networks.

Private network equipment

Includes all the equipment installed at telecommunications users premises.

PABXs and key systems: private telecommunications switches used for switching incoming and outgoing calls.

Telephone sets includes domestic and business phones. Mobile terminal devices are not included in this category.

Mobile equipment (domestic and business): this segment includes mobile terminal devices, e.g. cordless phones and GSM hand-held devices, car phones, CTx and DECT systems, pagers. Equipment used in the running of a public wireless network is not included.

Other terminal equipment includes domestic and business private equipment not otherwise counted above. This includes fax machines, answering machines, audio conferencing, video conferencing and automatic call distribution equipment.

11.2.2. Telecommunications services

Telephone services: this segment includes carrier service revenues for residential, business, national and international voice services.

Mobile telephone services: this segment includes service revenues from analogue, digital and telepoint mobile networks (carphones and personal phones).

Switched data and leased-line services: this segment includes service revenues for the following categories:

- *Private line services:* a private line is a fixed connection between two points. Private lines are leased to a single customer, and only the traffic of that customer can travel through the circuit. Tariffs are based on fixed price per distance segment. No time or traffic related charges are made.
- *Switched data services:* this segment includes service revenues from packet switched data networks, circuit switched networks, value-added networks and ISDN services.

CaTV services: includes revenues from basic CaTV subscriber service providing transmission improvement and/or added broadcast channels, plus revenues from auxiliary CaTV services (such as pay-TV, security services, or shopping revenues) when provided via a separate CaTV network. This includes revenues from any operator, public or private.

11.3. Performance measures

11.3.1. Trade statistics

All trade statistics are presented in current ECU and are based upon official European Union data. All conventions common in the presentation of such statistics have been observed. For a full treatment of this complex area readers are referred to the publications of the Customs Co-operation Council and Eurostat. Data have been selected based upon standard sub-headings of the Combined Nomenclature as listed below.

The reported areas (or grouping of countries) are: intra-EU (imports/exports occurring between a reporting country and a trading partner that are both within the EU), extra-EU (imports/exports occurring between one reporting/trading country in the European Union and one reporting/trading partner outside the EU).

Values of imports are generally stated at customs value or by reference to the concept of customs value (cif); exports are stated at the value of the goods at the place and time that they leave the statistical area of the exporting Member State (fob). The focus of the following analysis is on reporting countries in the European Union.

Please note: descriptions have been abbreviated. Product codes have been stated to indicate the level at which data was collected for this exercise. Thus, 84.69 should be considered to include all lower sub-headings below 84.69. Readers interested in the full details of the trade classification are referred to the publications listed below.

References for trade statistics:

1. Explanatory notes to the Combined Nomenclature of the European Union, published by the Office for the Official Publications for the European Commission.

2. Explanatory Notes to the Harmonised System Nomenclature, published by the Customs Co-operation Council.

List of import/export codes used to value IT and telecommunications hardware trade

84.69	typewriters and word processing machines
84.70	calculators: calculating machines, accounting machines, cash registers, postage franking machines, ticket-issuing machines and similar machines, incorporating a calculating device
84.43.12	offset printing machinery, sheet fed, office type, sheet size = < 22 x 36 cm
84.71	DP equipment: automatic data processing machines and units thereof; optical readers, machines for transcribing data onto data media in coded form, and machines for processing data
84.72	"other" office equipment: printers, hectograph or stencil duplicating machines, addressing machines, automatic banknote dispensers, coin-sorting machines, coin-counting (or wrapping) machines, pencil sharpening machines, perforating or stapling machines
84.73	parts for use with the machines of sub-headings 84.69-84.72
90.09	photocopiers
85.17	equipment used for line telephony/telegraphy: telephone sets, apparatus for carrier-current line systems, telegraphy apparatus, faxes, weather map plotters.
85.20.20	telephone answering machines incorporating a sound device

11.3.2. Production

Limited information is available for the correct evaluation of production, on the basis of the value-added contribution of each country.

An approximate relationship is therefore applied to compute production values:

production = market value + exports - imports

where market value is based upon EITO data, and trade data are based upon appropriately adjusted statistics.

For IT and telecommunications hardware this relationship is relatively straight forward to calculate, since data are readily available on both counts.

11.3.3. Industry leader's market share

Market share statistics are based upon aggregations of IDC research, in order to illustrate structural issues within the market, whilst at the same time preserving confidentiality.

11.3.4. Industry concentration

As for the industry leader's market share (see above), industry concentration is an aggregate market share statistic.

11.3.5. Inflation

All forecasts are expressed in nominal terms.

11.3.6. Exchange rates

The general rule in this edition of EITO is to use the ECU as the numeraire currency. Conversion of data from national currencies to ECUs, for both historical series and projections, has been carried out using the average exchange rates for 1997.

At the time of compilation of the statistical data and forecasts given in the EITO 99 yearbook, neither the average exchange rates for 1998, nor the final conversion rates of national currencies against the Euro were yet available.

On 1 January 1999, the Euro was adopted as the common currency of eleven Member States of the EU: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. On 31 December 1998, the conversion rates of the Euro against the eleven national currencies and the ECU (the latter, at the rate of one to one), were irrevocably fixed without changing the external value of the ECU against the US Dollar. It is the opinion of the Task Force that figures for the years 1999 onwards denominated in ECU in this edition of EITO may also be taken as their best estimates of figures denominated in Euro.

Irrevocably fixed conversion rates between the Euro and the currencies of the Member States adopting the Euro, 1 January 1999

1 Euro	= 1 ECU
	= 40.3399 Belgian francs
	= 1.95583 German marks
	= 166.386 Spanish pesetas
	= 6.55957 French francs
	= 0.787564 Irish pounds
	= 1,936.27 Italian lire
	= 40.3399 Luxembourg francs
	= 2.20371 Dutch guilders
	= 13.7603 Austrian schillings
	= 200.482 Portuguese escudos
	= 5.94573 Finnish marks

Future editions of the EITO will adopt the Euro as the numeraire currency and will follow the practice which will be adopted by the various European institutions, notably Eurostat, in presentation of data in their publications.

In this edition all market values are converted from national currencies at 1997 exchange rates of those currencies against the ECU for all the years of the historical and the forecast period. The exchange rates used for all except the East European markets are based upon the averages of daily rates for the individual currencies on the Paris money markets, as reported by the OECD.

Due to the characteristics of the local markets, Eastern European research has been carried out in a different fashion to that used for an established market. A different treatment is still necessary for Russia. In this case valuations continue to be made relative to a set of initial dollar values for equivalent Western machines. These reference values are then discounted by a variable amount which reflects the systems age. Finally, data is converted into ECU using the appropriate $/ECU exchange rate.

ECU exchange rates

(Units per ECU)

	1995	1996	1997
Austria	13.18	13.43	13.83
Belgium	38.56	39.32	40.54
Denmark	7.32	7.36	7.49
Finland	5.71	5.83	5.88
France	6.52	6.49	6.62
Germany	1.87	1.91	1.97
Greece	302.75	305.48	309.41
Ireland	0.82	0.79	0.75
Italy	2,129.41	1,958.68	1,930.84
Netherlands	2.09	2.14	2.21
Norway	8.29	8.20	8.02
Portugal	195.95	195.75	198.64
Spain	163.01	150.82	165.99
Sweden	9.32	8.51	8.66
Switzerland	1.54	1.57	1.64
UK	0.82	0.81	0.69
US	1.31	1.27	1.13
Japan	123.01	136.71	137.19
Source: OECD			
Local commercial rates			
Czech Republic (Crowns)	33.4	34.4	40.3
Hungary (Forints)	193.7	185.4	237.1
Poland (Zlotys)	3.5	3.5	4.2
Russia* (Roubles)	6,834.0	6,248.0	n.a.
Slovak Republic (Crowns)	39.0	38.6	42.6
Slovenia (Tolars)	n.a.	n.a.	n.a.
Estonia (Kroons)	n.a.	n.a.	n.a.

* Russia: research is carried out using US Dollars rather than Roubles. The Russian currency's steep devaluation makes local currency research impossible (e.g., in December 1995, the Rouble to ECU exchange rate was 7,140 Roubles to the ECU).

Alphabetical Index

A

B

C

D

E

H

I

J

L

M

P

Q

R

S

T

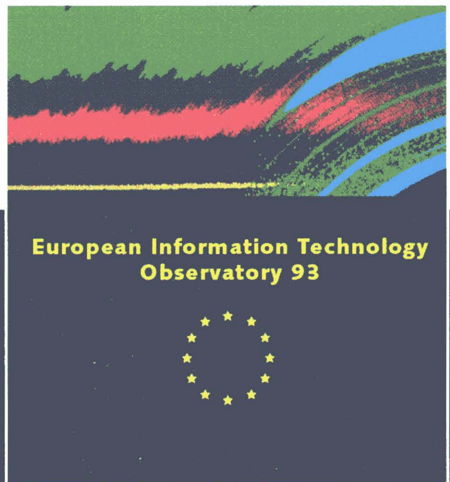
W

X

Y

European Information Technology Observatory –

Previous editions

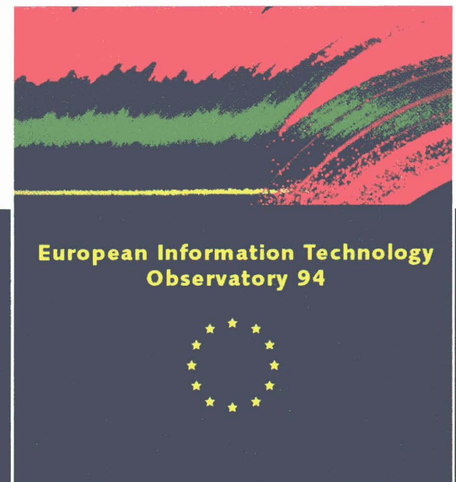


93

Information technology standardisation

The European software
and services marketplace

Environmental achievement
in information technology



94

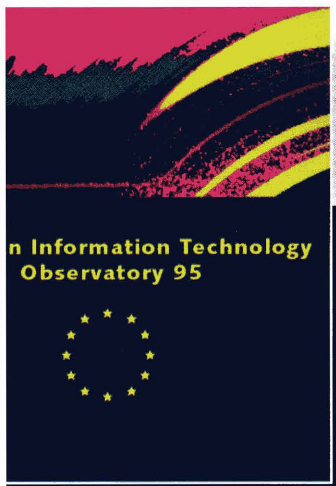
Information technology markets
of Eastern Europe

Mobile computing and
communications in Europe:
towards a digital wireless world

The information technology market
in Europe's public administrations

Copies still available.
Apply to EITO members
or sponsors.

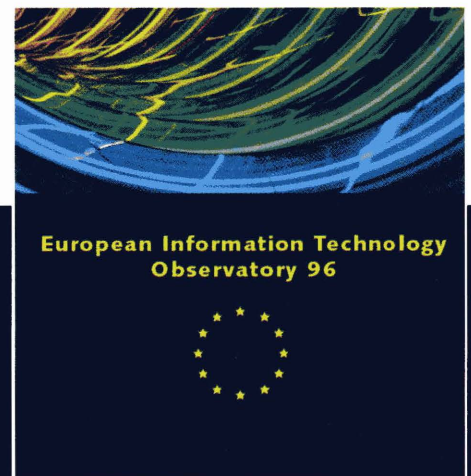
Order addresses on front
or back cover page.



ean information infrastructure
nvergence
tion technology,
unications and media

and the small office/home office
r IT in Europe –
ance of information highways

mputing and communications
owards a digital wireless world

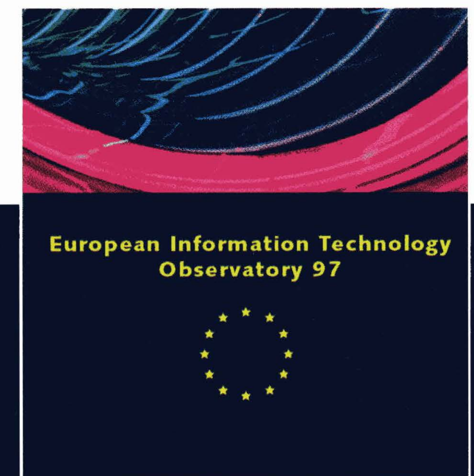


96

Towards the Information Society:
new network services and applications

The ICT market in Europe's banking
and financial services

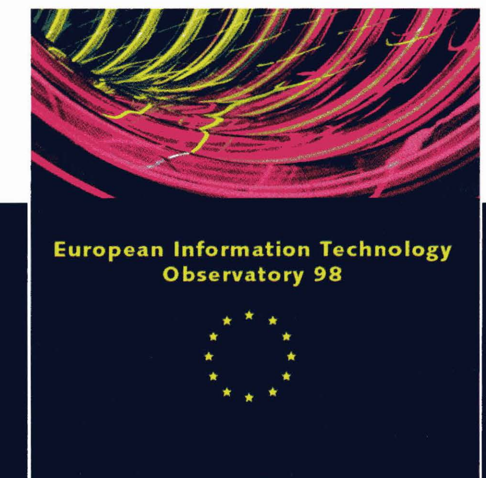
The evolution of ICT distribution channels
in Europe



97

The future of the Internet

Electronic commerce over the Internet



98

ICT for European homes:
devices, services and applications

The Euro: impact on information technology

The convergence of voice and data
communications

Telework: status, development and issues

European Information Technology Observatory – EITO

EITO Members

eurobit

EUROBIT · European Association of Manufacturers
of Business Machines and Information Technology Industry
Lyoner Strasse 18, D-60528 Frankfurt am Main
Tel. + 49-69-66 03 15 18, Fax + 49-69-66 03 15 10
Internet: http://www.eurobit.org

ECTEL

The European Telecommunications and Professional
Electronics Industry, c/o ZVEI/FV K
Stresemannallee 19, D-60596 Frankfurt am Main
Tel. + 49-69-63 02 21 3, Fax + 49-69-63 02 28 8
Internet: FVK.ZVEI@t-online.de

CeBIT HANNOVER
World Business Fair · Office Automation
Information Technology · Telecommunications

CeBIT HOME
World of Home and
Consumer Electronics

Deutsche Messe AG, Messegelände, D-30521 Hannover
Tel. + 49-511-89 33 100, Fax + 49-511-89 33 102
Internet: http://www.cebit.de
http://www.cebithome.de

SIMO TCI
FERIA INTERNACIONAL DE INFORMATICA, MULTIMEDIA Y COMUNICACIONES

IFEMA – SIMO TCI
Parque Ferial Juan Carlos I, E-28067 Madrid
Tel. + 34-1-722 50 00, Fax + 34-1-722 58 07
Internet: http://www.simo.ifema.es

smau
Esposizione internazionale
dell'informazione
& communications technology

Via Merano 18, I-20127 Milano
Tel. + 39-02-28 31 31, Fax + 39-02-28 31 32 13
Internet: http://www.smau.it/magellano

EITO Sponsors

European Telework Development

European Telework Development, ETD Central Project Office
Fabrikvej 11, DK-8260 Viby J
Tel. + 45-86-28 64 55, Fax + 45-86-28 64 99
Internet: http://www.eto.org.uk

SYSTEMS

Computers, Software, Communications
Messe München GmbH, Messegelände, D-81823 München
Tel. + 49-89-949 203 50, Fax + 49-89-949 203 59
Internet: http://www.systems.de

Company Sponsors

Deutsche Telekom AG
Zentrale Bonn
Reuterstrasse 122, D-53129 Bonn
Tel. + 49-228-181 0, Fax + 49-228-181 88 72
Internet: http://www.telekom.de

TELECOM ITALIA

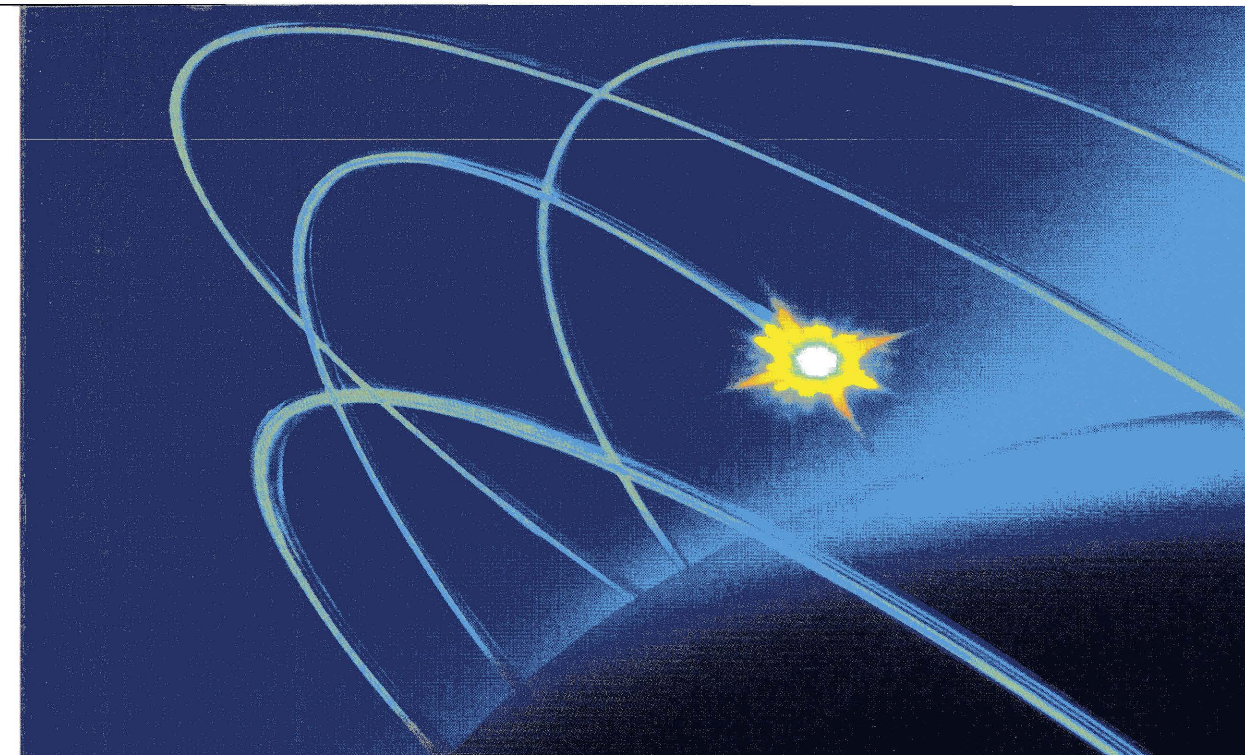
Telecom Italia
Direzione Generale
Via Flaminia 189, I-00196 Roma
Tel. + 39-06-368 81, Fax + 39-06-36 88 29 65
Internet: http://www.telecomitalia.it

With the Support of

European Commission
DG III · Industry
Rue de la Loi 200, B-1049 Brussels
Tel. + 32-2-299 11 11, Fax + 32-2-295 01 38
Internet: ict-industries@dg3.cec.be

OECD OCDE PARIS

OECD
Directorate for Science, Technology and Industry
2 rue André-Pascal, F-75775 Paris Cedex 16
Tel. + 33-1-45 24-82 00, Fax + 33-1-45 24-85 00
Internet: http://www.oecd.org/dsti



ISSN 0947-4862
ISBN 3-8163-0378-1